THE RELATIONSHIP OF ELECTRICITY CONSUMPTION, EXPORT, AND ECONOMIC GROWTH IN ASEAN

CHANCHAMROEUN KUOCH

MASTER OF ECONOMICS

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A THESIS SUBMITTED TO CHIANG MAI UNIVERSITY IN PARTAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF ECONOMICS

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THIS THESIS HAS BEEN APPROVED TO BE A PARTIAL FULFILLMENT OF
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ABSTRACT

In this paper, the author explores the relationship of electricity consumption, export, and economic growth of eight ASEAN countries over the period 1995-2011 by using the panel ARDL approach. To date, there are no other studies that explore estimations between economic growth and determinant factors. This will be the first paper to produce the estimation among economic growth, electricity consumption, and export by employing PMG and MG estimators. In this research there are four steps of methodology. First the panel unit root tests are used to test the stationary of those variables. Second, the author used Pool Mean group (PMG) estimator and Mean Group (MG) estimator to estimate the short and long run relation among those variables. Then, Hausman test is used to choose the best estimator between PMG and MG. Last but not least, Fully Modified Ordinary Least Square (FMOLS) which proposed by Pedroni (2000) in this paper that estimate the coefficient of each panel group.

The macroeconomic variables are lnGDP, lnEC, lnEX, lnK, and lnL. The author proposes to use some methods to test the unit root namely LLC (2002), Im, Pearan and Shin (2003), and Maddala and Wu (1999). There are two steps of using the method in this research; first, Pesaran (1999) introduced the Hausman test to test the hypothesis of inconsistency of an estimator. After using the Hausman test, the results

show that there is a long run relation between economic growth and determinant factors by using PMG. Additionally, in the short run export and labor have a positive relation to economic growth; export and electricity consumption will lead economic growth in ASEAN. Furthermore, the author also used the Fully Modified Ordinary Least Square (FMOLS) method to test the cointegration of those panel data. The empirical result shows that electricity consumption, export, and capital are significance so that the increase of electricity consumption, export, and capital can improve the economic growth in ASEAN.

This paper will be useful for governments and other researchers to explore further about energy and export policy. There are a long run relation among electricity consumption, export, and capital in ASEAN so that electricity consumption, export, and capital are the important engine to improve the economic growth in ASEAN. Government should have appropriate policy to invest in electricity production and improve export in order to improve the economic growth in this region. Furthermore, government should create friendly environment for FDI in order to attract more capital to this region.

หัวข้อวิทยานิพนธ์ ความสัมพันธ์ระหว่างการบริโภคไฟฟ้า การส่งออก และการเจริญเติบโตของประเทศในอาเซียน

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บทคัดย่อ

ในบทความนี้ผู้ศึกษาได้ทำการสำรวจความสัมพันธ์ของปริมาณการใช้ไฟฟ้า การส่งออก และการเติบโตทางเศรษฐกิจของประเทศในกลุ่มอาเซียน 8 ประเทศ ในช่วงปี 1995-2011 โดยใช้วิธีการแบบ Auto-Regressive Distributed Lag (ARDL) ในวันนี้ยังไม่มีงานวิจัยอื่นที่ได้ทำการสำรวจการประมาณระหว่างการเติบโตทางเศรษฐกิจ ปริมาณการใช้ไฟฟ้า และปัจจัยเฉพาะ งานวิจัยนี้จะเป็นงานวิจัยชิ้นแรกที่จะได้นำเสนอการประมาณค่าระหว่างความเจริญเติบโตทางเศรษฐกิจ ปริมาณการใช้ไฟฟ้า และการส่งออกโดยวิธีการประเมินค่าแบบ PMG และ การประเมินค่าแบบ MG ในงานวิจัยชิ้นนี้มีวิธีการศึกษาทั้งหมด 4 วิธี โดนวิธีแรกได้ใช้การทดสอบแบบพาแนลยูนิตรูท (panel unit root test) ใช้การทดสอบในกลุ่มตัวแปรที่หยุดนิ่งแล้ว วิธีที่สองผู้เขียนได้ใช้วิธีการประเมินค่า PMG และการประเมินค่าแบบ MG เพื่อประเมินความสัมพันธ์ตัวแปรในช่วงระยะสั้นกับตัวแปรในระยะยาว จากนั้นใช้วิธีการทดสอบแบบ Hausman คือเลือกค่าที่ดีที่สุดที่มาจากการประเมินค่าระหว่าง PMG และ MG และวิธีการสุดท้ายแต่ไม่ท้ายสุด คือการประเมินค่าแบบจำลองด้วยวิธี Full Modified Ordinary Least Square (FMOLS) ซึ่งนำเสนอโดย Pedroni(2002) ในงานวิจัยชิ้นนี้ได้นำเสนอการประเมินค่าสัมประสิทธ์ของพาแนลแต่ละกลุ่ม

ตัวแปนทางเศรษฐกิจมหาภาคที่มี lnGDP, lnEC, InK, และlnL ซึ่งผู้เขียนจะได้เสนอวิธีการบางอย่างเพื่อทดสอบ unit root ในชื่อของ LLL (2002), Im, Pearan และ Shin(2003) และMaddala และ Wu(1999) มีสองขั้นตอนในการใช้วิธีการวิจัยครั้งนี้ คือ วิธีของ Pesaran(1999) ได้นำเสนอการทดสอบของ Hausman เพื่อทดสอบสมมติฐานของความไม่สอดคล้องกันของการประมาณการ

หลังจากที่ใช้การทดสอบของ Hausman ผลจากการทดสอบแสดงให้เห็นว่ามีความสัมพันธ์ระยะยาว ระหว่างการเติบโตทางเศรษฐกิจ และปัจจัยชี้เฉพาะ โดยการใช้ PMG นอกจากนี้ในระยะสั้นการส่งออกและแรงงานมีความสัมพันธ์ในเชิงบวกต่อการเติบโตทางเศรษฐกิจ ไม่ว่าจะเป็นการส่งออกและการใช้ปริมาณไฟฟ้าที่มากขึ้นซึ่งจะนำไปสู้การเติบโตทางเศรษฐกิจในภูมิภาคอาเซียน และนอกจากนี้ผู้เขียนยังได้ใช้วิธีการ Full Modified Ordinary Least Square (FMOLS) เพื่อทดสอบการรวมตัวกันของข้อมูลพาแนลเหล่านั้น ผลการทดสอบแสดงให้เห็นว่าการใช้ไฟฟ้า การส่งออก และเงินทุนที่มีความสำคัญเพื่อให้การเพิ่มขึ้นของปริมาณการใช้ไฟฟ้า การส่งออก และเงินทุนสามารถปรับปรุงการเติบโตทางเศรษฐกิจในภูมิภาคอาเซียนได้ ค่าสัมประสิทธ์ของ lnEC, lnEX และ LNK เป็น 0.34, 0.18 และ 0.15 ตามลำดับ

งานวิจัยชิ้นนี้อาจจะเป็นประโยชน์ไม่มากก็น้อยสำหรับรัฐบาลและนักวิจัยท่านอื่น ที่มีความสนใจในการสำรวจเพิ่มเติมเกี่ยวกับนโยบายทางด้านพลังงาน และ การส่งออก ซึ่งมีความสัมพันธ์ระยะยาวท่ามกลางปริมาณการใช้ไฟฟ้า การส่งออก และเงินทุนในเขตภูมิภาคอาเซียนนี้เพื่อให้ปริมาณการใช้ไฟฟ้า การส่งออก และเงินทุนเป็นเครื่องมือที่สำคัญในการปรับปรุงการเจริญเติบโตทางเศรษฐกิจในอาเซียน และรัฐบาลควรมีนโยบายที่เหมาะสมในการลงทุนในการผลิตไฟฟ้าและการปรับปรุงการส่งออกเพื่อเตรียมพร้อง และรองรับมือกับการเจริญเติบโตทางเศรษฐกิจในภูมิภาคนี้ นอกจากนี้รัฐบาลควรสร้างสภาพแวดล้อมที่ดีและเป็นมิตรสำหรับการลงทุนโดยตรงในการที่จะดึงดูดเงินทุนในภูมิภาคนี้

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CHAPTER 1

Introduction

1.1 The Rationale Background

ASEAN has ten countries, including Kingdom of Cambodia (Cambodia), Lao People's Democratic Republic (Lao PDR), Kingdom of Thailand (Thailand), Socialist Republic of Vietnam (Vietnam), Republic of the Union of Myanmar (Myanmar), Federation of Malaysia (Malaysia), Republic of Indonesia (Indonesia), Republic of Singapore (Singapore), Republic of Philippines (Philippines), and Nation of Brunei, Adobe of Peace (Brunei). This region has the potential for an increase in its economic growth rate, demography, and resources. In comparison to the world, ASEAN contributed account for 3.11% of global GDP (2011) and hosted 8.59% of the global population (2011). There are three kinds of categorized of countries in ASEAN such as agricultural based countries, transforming countries, and urbanized countries. The agricultural based countries in ASEAN countries namely Cambodia, Lao PDR, and Myanmar which agriculture contributes for more than 30% of economy. In addition, there are five countries that are transforming countries namely Indonesia, Malaysia, Philippines, Thailand, and Vietnam which agriculture contributes for 15 percent, 7.7 percent, 19.1 percent, 9.3 percent, and 20.2 percent of GDP, respectively. Besides that, there are only two countries namely Singapore and Brunei that are urbanized countries which their economy do not depend on agriculture. ASEAN countries are the potential region which the economic growth rate in this region is very noticeable. In 2011, the growth rate of this region was 4.9% compared with Japan -0.8%, 3.6% in Korea, 6.8% in India, and 9.2% in China. The financial crisis of 1997 which brought an economic downturn in this region and this crisis brought more economic crisis in some countries in ASEAN namely Thailand, Philippines, Vietnam, Indonesia, Singapore, Malaysia, and Brunei which are the most of transforming countries.

In 2011 ASEAN countries which contributed 3.11% of global GDP and this region has very potential to growth because most of countries have the potential of resources, labor, and capital. Moreover, the purchasing power of this region also increases because of the GDP per capita of this region increase rapidly. In fact, GDP per capita of least developed country namely Cambodia had the increase trend of GDP per capita from $ 262 to $ 637; it means that this country has improved the growth of purchasing power by improving the economic growth rate around 7% each year. Beside the least developed country in Cambodia, the developed countries in this region namely Singapore and Brunei increased the GDP per capita rapidly since 1995 to 2011.

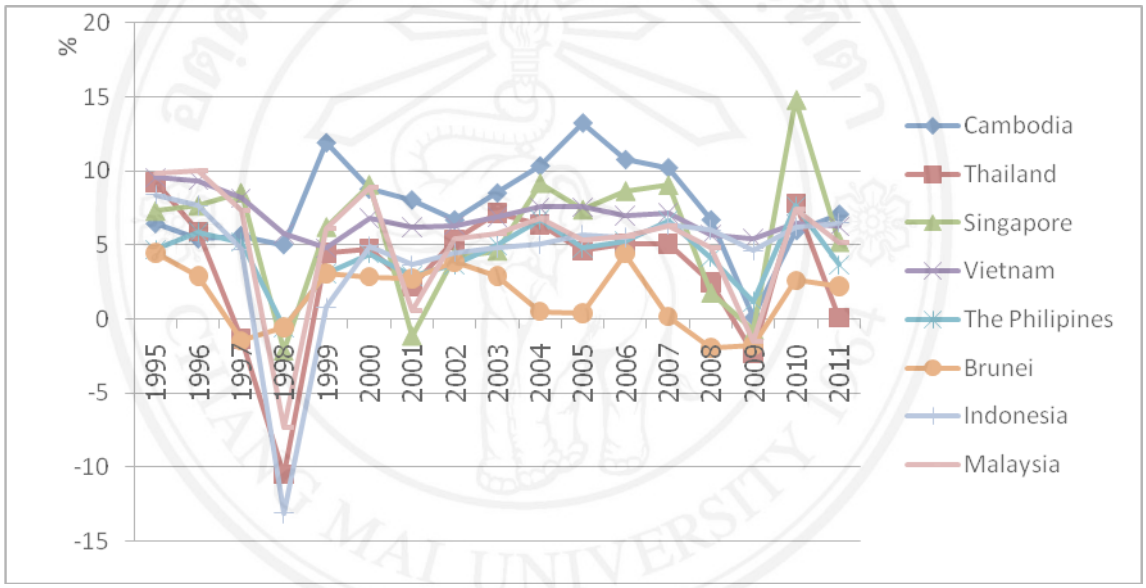

Figure 1.1 GDP Growth rate of eight ASEAN countries
Source: World Bank Indicator, 2012

ASEAN is a region which has the potential to growth very rapidly. The figure 1.1 shows the GDP growth rate per annul of ASEAN countries; the figure reveals the GDP growth rate of ASEAN countries since 1995 to 2011. This graph shows that there were two economic down turn in 1997 and 2008. For Cambodia in 1997 the economic growth in this country was in positive because this country was not involved much in international economy. Indeed, Thailand, Malaysia, Indonesia, Brunei, Philippines, and Singapore faced economic down turn and the growth rate

became negative. Moreover, after the world economic crisis in 2008, the economy in ASEAN had the positive growth so that it is very significant to growth in this region in the near future. After finished economic crisis, government of ASEAN countries used the monetary policy and fiscal policy to improve the growth of the countries. The governments of Cambodia, Thailand, and Vietnam still improved the expenditure on agricultural sector because those countries depend on agriculture to export in order to improve the economic growth and economic development in those countries. In contrast to Singapore reduced the expenditure on agricultural sector to other sector; in 1995 and 2011 Singaporean government spent on agriculture $ 107.38million and $69.75 million, respectively. Although the governments of each country spent differently in each sector, there was economic growth in this region.

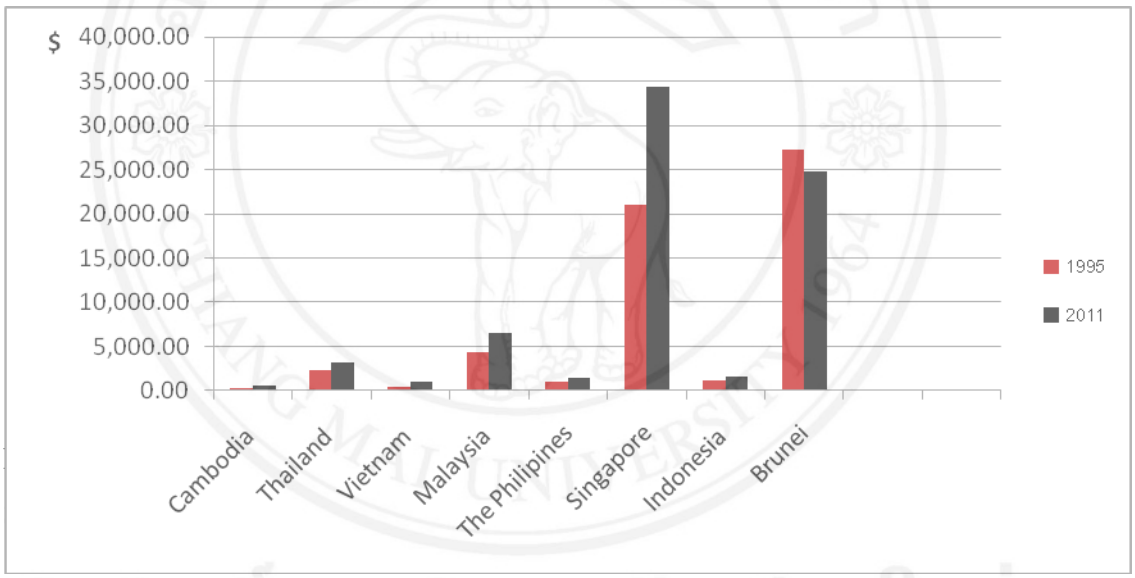

Figure 1.2 GDP per capita of eight ASEAN between 1995 and 2011

Figure 1.2 shows the GDP per capita of eight ASEAN countries between 1995 and 2011. Singapore and Brunei are the two leaders of GDP per capita since 1995 until now Singapore can earn much GDP per capita because she became the international hub for international trade, and human capital in this country is knowledge based oriented. Among the eight members of ASEAN, Cambodia is the lowest GDP per capita because this country faced many civil wars for more than three decades and it just got the full positive peace in 1998. Although Cambodia was the

least GDP per capita in ASEAN from 1995 to 2011, it had a bit increase of GDP per capita in this country which increased from $ 262.74 to $637.26. Moreover, most of countries increased their GDP per capita from 1995 to 2011. This region has been believed that there will be the free flow of products and services to this region so that all of the member of this region will improve the GDP per capita of those countries and lead to improve the economic growth of this region. In addition, the free flow of investors will come to the poor countries such as Cambodia, Vietnam, and Philippines. After the ASEAN integration, it is believed that the GDP per capita of those countries will increase and bring more prosperity to this region.

ASEAN integration has created more opportunities for all investors to take part with ASEAN members especially the least developed countries such as Laos, Vietnam, Cambodia, and Myanmar that need more capital inflow to improve their economy. Energy is an important factor to improve the economic growth in this region especially electricity; electricity becomes an important factor in daily life because without it, development cannot be improved rapidly and everything cannot be run smoothly. Moreover, all the ASEAN's leaders put in effort to improve the policy related to electricity in order to fulfill the increase in demand for electricity. In addition, with the assumption of a growth rate of 5.2% per annum from 2007 to 2030, ASEAN will need the energy growth rate at 4.4% per annum (Shigeru, 2011). Because of the demand of energy and electricity each year, all of ASEAN has to improve in electricity production each year in order to fulfill the trend of the development growth.

Over the rapid economic growth of ASEAN, ASEAN increased the huge amount of electricity production in order to fulfill the increase of electricity consumption. Malaysia accelerated the increase of electricity consumption in the manufactured sector. Since the practice of industrial plan in the mid-1980s, electricity consumption increased from 23,016 million kWh to 84,841million kWh. Meanwhile, Thailand is also the leading country in producing electricity in order to fulfill the demand of electricity in manufacture and production. From 1995 to 2011, the increase of electricity production increased from 80,083 million kWh to 155,986 million kWh, respectively. The figure 1.3 shows the electricity production of ASEAN during 1995-2011 and the trend of the electricity production of ASEAN increases rapidly because

of the increase in electricity demand of ASEAN countries and the increasing of economic activities in this region. Thailand and Indonesia are the leading countries in electricity production in ASEAN and also the heart of producing more electricity in this region. Indeed, Cambodia and Brunei are the two countries that have the less electricity production in the region. Moreover, most ASEAN leaders make the policies related to electricity in order to fulfill the increase of economic growth in this area. Because of the lack of electricity in this area and the increase of economic growth in ASEAN countries, all of the ASEAN leaders cooperate to work on sustainable energy development in this region. During the years of economic crisis in 1997 and 2008, electricity production in this region still continued to grow because electricity production played very important role in ASEAN's economy.

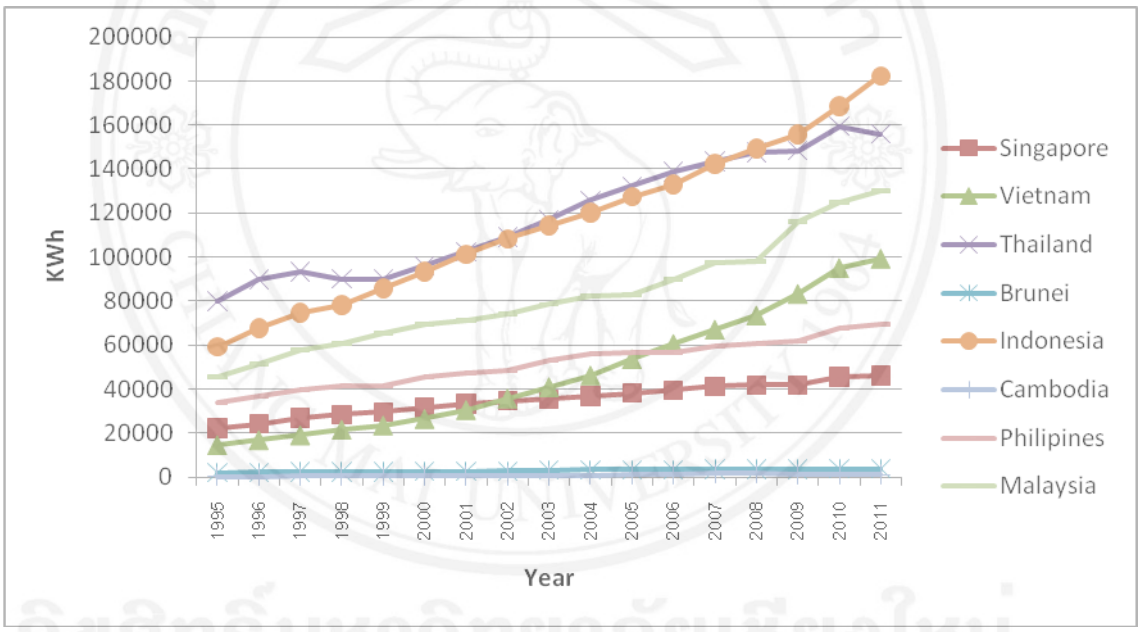

Figure 1.3 Electricity Production of ASEAN during 1995-2011

Electricity becomes very important in economic development around the world especially in South East Asia where most countries are developing countries. To be a modern society, society needs to have an increase of information and communication technologies (ICTs) so that more people have access to internet and modern technologies; in order to access those technologies; it needs more energy from renewable and nonrenewable resources to produce electricity in the society (Gurgul et

al, 2012). ASEAN which contains ten countries, most of which are developing countries, are producing more electricity in order to fulfill the demand of people and increasing of population in this area.

Beside the growth of electricity production of ASEAN countries, export also plays very important in this region in order to improve the countries. Since 1997, ASEAN financial crisis caused many problems in Thailand which also spread to all ASEAN members as a whole. After that, the regional groups of these countries extended their trade and economic integration in the region. In addition, ASEAN Economic Community (AEC) in 2015 is also the starting point of economic integration of those countries by improving exports not only intra ASEAN but also extra ASEAN.

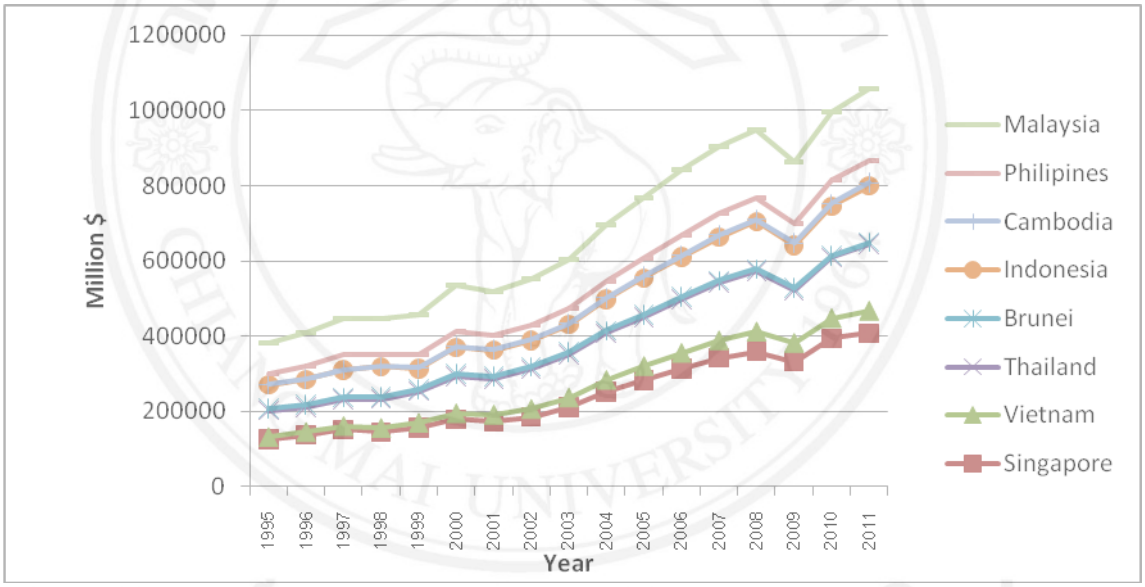

Figure 1.4 Export of ASEAN during 1995-2011
Source: World Bank Indicator, 2012

Figure 1.4 shows the export growth trend of ASEAN countries from 1995 to 2011. Singapore, Malaysia, and Thailand are the three leading countries of exporting goods and services not only intra ASEAN but also extra ASEAN. In addition, the trends of growth are very significant to growth of ASEAN as most ASEAN countries have a growth rate of around 5%. Exports become very important for ASEAN countries especially for Thailand, Singapore, and Malaysia which depend on exports

to increase the growth in those countries. Indeed, the policy of exports led growth is very crucial for ASEAN because there is the positive growth rate of growth of exports, which contribute to the growth of GDP of ASEAN.

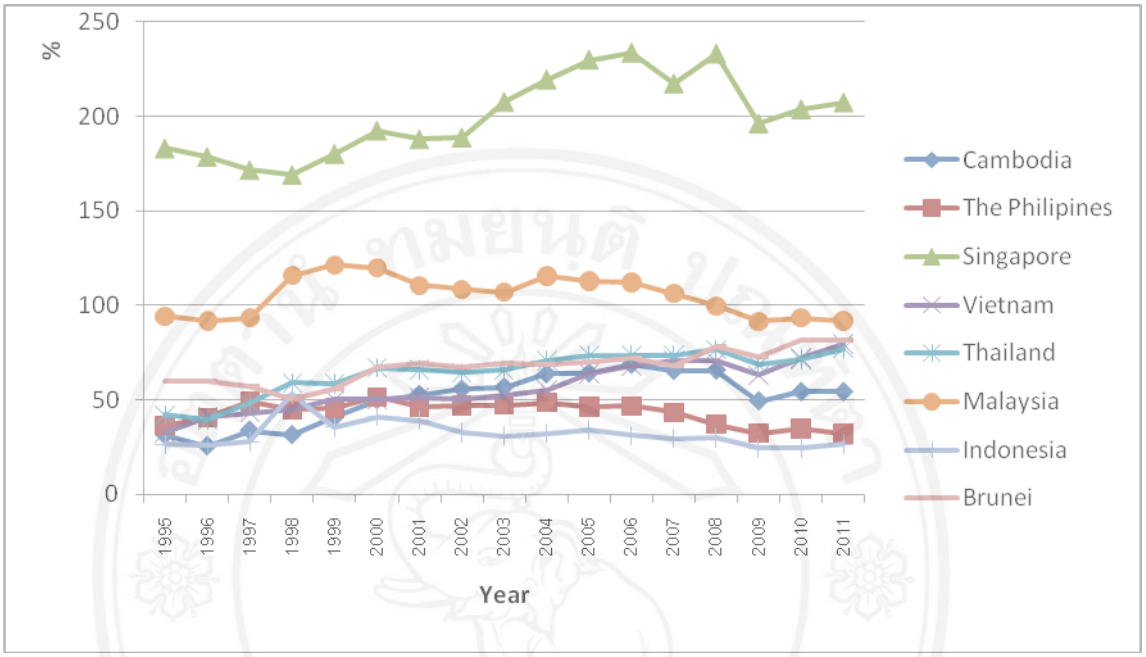

Figure 1.5 The percentage of export goods and services in ASEAN (% of GDP)

ASEAN countries so that export plays very important role in those countries. Indeed, export contributes much of economic growth. In this graph, the percentage of export of Singapore, Malaysia, and Thailand are the three leading countries which export has the crucial role in their economy. All in all, government needs to have an appropriate policy on export in order to improve the economic growth in this region. For above mention, the author would like to explore the main recent factors that have determined the economy of eight ASEAN countries.

1.2 Objectives of Study

The major purposes of this paper aimed to understand the factors that determine the economic growth of eight ASEAN members. Moreover, to improve the economic development and economic growth, government needs to improve what

sector that can determine the economic growth of country. The objectives of research are as follows:

- Employ the method of PMG and MG to estimate the determinant factors of economic growth of eight ASEAN members
- Explore the factors that determine to GDP per capita of eight ASEAN countries
- To estimate the coefficient of the factors determine the economic growth of eight ASEAN countries in long run and short run
- Employ the method of FMOLS to estimate the relationship between endogenous and exogenous variables

1.3 Scope of the Study

The study of the relation of electricity consumption, export, and economic growth of eight ASEAN countries was conducted in yearly from 1995-2011. Indeed, the variables employed were electricity consumption per capita (measured in million kWh per capita), real GDP per capita (constant 2005 US$), real export per capita (constant 2005 US$), real gross capital formation (constant 2005 US$), and labor force participation rate (population 15-64). Indeed, all of data is collected from World Bank indicator.

1.4 Advantage of the Study

Electricity and export are the two factors that can improve the economic growth of eight ASEAN members. The expected outcomes of this research are to explore determinant factors of eight ASEAN economic growth and to recognize the long run relation of economic growth that influenced by some variables include electricity consumption per capita, export per capita, labor force, and capital formation per capita. There are some advantages of doing this research; first, this research will be useful government to make a consideration on making on export and energy policy. Export is very important in ASEAN so government needs to take more export oriented in order to improve the economic in this region. Second, this research

is useful for researchers and learners who need to know more about the relationship of electricity consumption, export, and economic growth in ASEAN.

1.5 Outline of the Chapters

There are three main ideas in this research about the relation of electricity consumption, export, and economic growth of eight ASEAN countries from 1995-2011.There are many scholars that researched about the factors that determine the economic growth and the result of those researches were some researches revealed that there is unidirectional causality between economic growth and determinant factors of economic growth and vice versa. In addition, some researches showed that there are bidirectional causality between economic growth and determinant factors of economic growth. The paper firstly illustrates the factors that determine the economic growth of eight ASEAN countries. Secondly, the paper tries to find out how much of those economic factors affect the degree of economic growth in ASEAN countries. Thirdly, regarding to the relation of electricity consumption, export, and economic growth of eight ASEAN countries, the data was got from World Development Indicator from year 1995-2011 of eight ASEAN countries namely Cambodia, Thailand, Vietnam, Malaysia, Indonesia, Philippines, Brunei, and Singapore. Also, this paper used panel ARDL to estimate the long and short run relation of economic growth and determinant factors of economic growth. In addition, this paper used the method of Pool Mean Group Estimator (PMG) and Mean Group Estimator (MG) to estimate the long and short run of those variables. Last but not least, the research used the method of Fully Modified Ordinary Least Square (FMOLS) to estimate the cointegration of each panel data. The evidence of empirical results of this research provided the implication of the determinant factors and how those factors affect the economic growth of eight ASEAN countries.

CHAPTER 2

Literature Review

2.1 Methodology Review

There are some authors that used the method of Pool Mean Group Estimation (PMG) to estimate the long run and short run of those variables. PMG proposed by Peasaran (1999) is the method that can estimate the long and short run equation. The below literature review are the researches which related to methodology of Pool Mean Group Estimation (PMG).

Bassanini et al (2002) research the human matter in OECD countries by using Pool Mean Group Estimation (PMG). The research is from the year of 1971 to 1998 for 27 years by using the PMG to estimate the long run and short run of 21 OECD countries. In addition, the research also got the data from OECD and the author tried to test the panel data by using the 27 years of data and 21 countries to estimate the long and short run relation. The variables that it used are GDP, saving rate, stock of human capital, and population; the author took GDP as the dependent variable and saving rate, stock of human capital, and population are independent variables. The methodology of this research used the Pool Mean Group Estimation (PMG) and after that it used the Hausman test to select the best model between Pool Mean Group (PMG) and Mean Group (MG). The result reveals that the Hauman test was not reject the hypothesis so that PMG consistent. Therefore, Pool Mean Group (PMG) is the best estimator to estimate the long and short run relation of OECD countries. The empirical result of this research reveals that stock of human capital impact to the GDP of OECD countries.

Iwata et al (2011) research the environmental Kuznet curve for CO_2 by using Pool Mean Group approach (PMG). The author employed the research of environmental Kunzet curve of OECD and non OECD countries of 28 countries by using the Pool Mean Group (PMG) approach to estimate the long and short run of the

relation of the emission of CO_2 and nuclear energy. In this research the author select 17 OECD countries and 11 non OECD countries and the data of this research got from World Bank Indicator (WDI) 2007. The variables in this research the author were emission CO_2, GDP per capita, and electricity produced from nuclear force. The author set the emission of CO_2 to be the dependent variable and GDP per capita and electricity produced from nuclear force as independent variables. The methodologies that the author used in this research are the panel unit root test. By estimate the data of OECD and non OECD countries it needed to test the unit root test by using Augmented Dickey Fuller (ADF), Phillip Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Based on Augmented Dickey Fuller (ADF), Phillip Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, $lnCO_2$, lny, $(lny)^2$, and lnnuc are accpect the null hypothesis of H_o so that it has the unit root. After taking the first differentiate, the variables of lny, $lnCO_2$, $(lny)^2$, and lnnuc are stationary at I(1). In addition, the author used Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) to select the lag of this model; the result revealed that ARDL (1,1,1,1). The empirical result showed that OECD countries employed the advance technology and had less impact to the global warming but in non OECD countries there was an increasing of income and the technological friendly of the OECD countries need to improve to non OECD countries.

Bangaké et al (2011) examined the research of internal capital mobility of African countries by using Pool Mean Group estimation (PMG). The author tried to estimate the panel data of 37 countries over the period of 1970-2006. The author got the data from World Development Indicator (WDI) and the variables used in this research are saving rate and investment rate. The methodology in this research the author proposed to use of econometric approach; the author proposed to use Impeasaran (2003), Levin, Lin, and Chu (LLC) (2002) and Breitung (2000) to estimate the panel unit root test. The result of panel unit root test shows that the variables of saving rate and investment rate cannot reject the hypothesis in level. After taking the differentiate, the variables are stationary in level I(1). The author used panel cointegration to estimate the relation among those variables; it was classified as within dimension and between dimension group of panel of CFA, non CFA, civil law, and common law countries. In addition, the author used the Pool Mean Group

proposed by Peasaran and Smith (1995); the author used the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) to estimate the best model of the equation;the result reveals that ARDL (1,1). The empirical result showed that the speed of adjustment was -0.240 significance at 0.01; therefore, there was a long run relation between saving rate and investment rate.

Bildirici et al (2013) employed the research of effects of oil production on economic growth in Eurasian countries by using panel ARDL approach. The research estimate the data over the period of 1993-2010 for oil exporting countries such as Azerbaijan, Kazakhstan, Russian Federation, and Turkmenistan. The methodologies that the author used panel unit root test, panel cointegration, Ganger causality test, PMG, and FMOLS. The author proposed to use the Augmented Dickey-Fuller (ADF) and Impeasaran (IPS) to test the unit root test of the variables. The variables cannot reject the null hypothesis in the level of the IPS and Peasaran methods so that it needs to take the first differentiate. After taking the first differentiate, the variables are stationary in I(1). By using panel cointegration to estimate the within dimension and between dimension of the panel, it revealed all the seven panel cointegration reject the null hypothesis at 5%; therefore, there was a long run relation between oil production and economic growth of Eurasian countries. After that, the author used the Ganger causality test to estiate causality of those variables. The result revealed that there was the bidirectional causality between oil production and economic growth. The speed of adjustment was -0.325 so it is the medium of the speed of ECT; if there is a shock in the economy, it will take more than 3 years to move to the equilibrium.

2.2 Electricity Consumption Review

There are many researches related to electricity consumption and economic growth and also used a lot of methods to forecast such as Johansen Ganger causality test, Hsiao causality test, ECM, and ARDL bound testing. The results of the researches reveal that there is unidirectional causality running from electricity consumption to economic growth and vice versa and other researches have bidirectional causality. Nicholas (2008), the author examined the relationship between energy consumption and economic growth in Tanzania from 1971-2006 by ARDL

bound testing approach and the empirical reveals that there is unidirectional causality test running from energy consumption to economic growth. Odiahmbo (2009), the author explored the relationship between energy consumption and economic growth in China and the result of the empirical research showed that there is bidirectional causality between energy consumption and economic growth. Ouédraogo (2009), this research analyzed the causality between electricity consumption and economic growth in Burkina Faso during 1968-2003 and the result showed that there is no cointegration between electricity consumption and economic growth but there is bidirectional causality between electricity consumption and economic growth. There are many studies of electricity consumption and economic growth but there is not enough study about ASEAN countries so that the author would like to explore the relationship of electricity consumption, export, and economic growth of ASEAN by using ARDL bound testing approach. To date, there is no study that has been researched about the electricity consumption, export, and growth of ASEAN countries by using Panel ARDL approach and this paper aims to fill this gap.

The research of Asafu-Adjaye (2000) examined the relationship between energy consumption and income of four Asia countries namely India, Indonesia, Philippines, and Thailand. It can see that India, Indonesia, Philippine, and Thailand are the counties depend on electricity consumption and the production has increased each year. The methodology that author used first of all the author tested the unit root taste by using ADF and PP test to test the stationary of the variables whether it stationary. After that it apply the cointegration approach and Error correction model (ECM) to test the speed of adjustment of those variables. The purpose of doing this research found out the causality relationship between income and energy consumption and the empirical results showed that all the variables were stationary in first level I(1) by using the ADF and PP test. Indeed, there is unidirectional causality running from energy consumption to income for India and Indonesia but Thailand and Philippines have bidirectional causality of energy consumption and income. The author Wolde-Rufael (2006) tried to examine the relation of electricity consumption and economic growth for 17 African countries from 1971-2001. Indeed, this research also used the newly developed technique of Pesaran (2001). Among those countries, only 12 countries had causality relationships. In addition, there were only six

countries that had unidirectional causality running from economic growth to electricity consumption and three countries have opposite causality relation from six countries and three countries have the bidirectional causality between electricity consumption and economic growth. The author Odhiambo (2009) explored the energy consumption and economic growth of Tanzania by using the ARDL bound testing approach in the period of 1971-2006. In this research, the author used ARDL bound testing approach which had fewer researches that used this approach; the author tried to find out the relationship among energy consumption, electricity consumption, and GDP. Before estimate the relation among those variables, it needed to taste the stationary of the data by using Phllip-Perron test and Ng-Perron to estimate the stationary. The empirical results of bound testing showed that there is a strong long run relationship between energy consumption and economic growth; the result revealed that there is both short and long run causality between energy consumption and GDP. Indeed, the result of causality test showed that there is unidirectional causality running from energy consumption to economic growth in Tanzania.

The research of Omotor (2008) explored the energy consumption and economic growth of Nigeria. In this research the variables that used are electricity consumption per capita, gross fixed capital formation, total labor force and oil price. This research the author used ARDL approach to estimate the relation among those variables; in this research the author used Schwarz Bayesian Criterion (SBC) and Akaike Information Criterion (AIC) to select the optimal lag for equation. The author also tested the unit root of data in order to test whether the data is stationary. After that, the cointegration has to be examined in order to test whether those variables are cointegrated. In addition, the author used the Hsiao causality of those variables. The result of this research showed that there is bidirectional causality between energy consumption and economic growth in Nigeria so energy consumption plays important role in Nigeria's economy. Government should improve in energy consumption in order to improve the economic growth in this country. Qiang (2009) examined the relationship between energy consumption growth and economic growth in China. By doing this research, the author also used the econometric method to analyze the variables; there is the ADF test, Ganger test, and ECM technique. In addition, after testing the variables by using the ADF to test the stationary of variables, it revealed

that both of energy consumption and GDP are stationary in the first level and the empirical results show that there is a long run cointegration of energy consumption and economic growth in China. Indeed, the results showed that there is bidirectional causality of energy consumption and economic growth.

Lean et al (2010) explored the dynamics of aggregate output, electricity consumption, and exports in Malaysia. For this study, energy, export, capital, and labor were treated as separate factors of production. In addition, the first hypotheses of this research are the export lead growth which is consistent with the theory of Solow-Swan growth. In addition, the other hypotheses have set the relationship between electricity consumption and export; if there is Ganger causality between these two variables, it means that reducing electricity consumption will reduce economic growth. Export is the engine of economic growth. Indeed, if there is a Ganger causality test running from exports to electricity consumption or in no either direction, it means that energy policy has little effect on export growth. The author got the data in this study from the world development indicators. The empirical results of this study revealed that by using the TYDL approach to Ganger Causality, there is a 1% level Granger causality running from capital, labor, exports, and electricity consumption to GDP. Besides that, the author tested the unit root test by using the method of Fisher type (ADF) and Phllip-Perron, and the results showed that all the variables are stationary in the first level I(1). Indeed, after testing the cointegration of Johansen, it indicated that all variables are cointegrated. In addition, for the empirical results of the this research, both TYDL approach and Johan cointegration test showed that there is bidirectional between energy consumption and aggregate output and exports Ganger cause aggregate output.

Ouédraogo (2009) analyzed the causality between electricity consumption and economic growth in Burkina Faso in 1968-2003. The variables used in this research are electricity consumption, capital and GDP. Indeed, the author used ADF test and PP test to test the unit root test of the variables. Overall, electricity consumption, capital, and GDP are stationary in the first level by using both approaches. After that it estimate the cointegration among those variables and chose AIC and SBIC to select the optimal lag for variables. Both short and long run electricity consumption is significance and cause Ganger causality to GDP. The results showed that there is no

causality between electricity consumption and investment; but there is a bidirectional causal relationship between GDP and electricity. The research of Odiahmbo (2010) examined the relationship between electricity consumption and economic growth in Kenya from 1972-2006. The author used PP test and DF test to test the unit root test of those variables. After testing unit root test, the result revealed that those variables are stationary in the first level because the t-statistic is significance at first level. By using cointegration and error correction model, there is unidirectional causality between electricity consumption and economic growth in Kenya. Indeed, electricity consumption and economic growth Ganger cause labor participation. In addition, this research also uses an econometric technique to test the unit root test of data. After testing the unit root test, it shows that all of the data are non-stationary in level so that it needs to differentiate those data. The empirical result showed that there are both short and long run causality running from electricity consumption to economic growth in Kenya so that electricity consumption is very crucial to Kenya in order to improve the country. The error correction mechanism (ECM) was -0.59 which was negative so that it implied that there were short and long run relation between electricity consumption and economic growth in Kenya; if there was any shock in that country, it will come back to equilibrium by 59% of expectation. Mutascu et al (2011**)** explored the relationship between real GDP and electricity consumption from 1998-2008 in Romania and in this research all the data are from the Eurostat database. In this study, the author uses the Phillips Perron and Dickey Fuller to test unit root taste of the data. The variables that used in this study are electricity consumption, GDP, and capital. The empirical revealed that GDP, electricity consumption, and capital have unit root in their level and stationary in the first differentiate. In addition, the methodologies that the author used are ARDL bound testing, the Toda Yamamoto, and Ganger causality tests have been used. By using Toda Yamamoto approach, the maximum lags were 2 and supported the direct causality from electricity consumption to GDP. In addition, the result of imply ARDL approach revealed that electricity consumption, capital, and economic growth are cointegrated in long run relation in Romania. The empirical results showed that there is unidirectional causality running from electricity consumption to economic growth. Therefore, electricity consumption and capital are the crucial engines in improving Romania economy.

Tang et al (2013) explored electricity consumption, energy prices, technology innovation, and economic growth in Malaysia. This research focus on the period of 1970-2009 and the data was got from the World Development Indicator. The empirical results showed that income has a positive effect on electricity consumption and the price of energy and technology innovation has negative effect on electricity consumption. Indeed, there is a Ganger causality of electricity consumption to economic growth and vice versa. Policy makers should invest in electricity consumption in order to fulfill the electricity demand of the country. In this research, the author used the econometric technique to achieve the goal of the study; the author used the methods of Phillips-Perron (PP test), Kwiatkowski–Phillips–Schmidt–Shin (KPSS) to test the unit root test of the data. In addition, the author followed the recommendation of Karanfil and Ozturk by using the bound testing approach of long run cointegration.

Aziz (2011) explored the relationship among energy consumption, energy price, and economic growth in Malaysia. In addition, in this research the author used the Ganger causality test in order to test the causality of those variables and also used the Johansen cointegration test. The variables that used in this research are energy consumption, aggregate output, and energy price; the author used ADF test and PP test to test the unit root test. The variable of energy consumption, Output, and energy price cannot reject the null hypothesis of unit root test so that it needed to take the first differentiate; the t-statistic showed significance in the first level of all the variables. Indeed, the result revealed that there is a long run cointegration of energy consumption, energy price, and economic growth in Malaysia. The implementation of energy conservation has little impact to the economic growth. All in all, energy consumption is very important in Malaysia. Magazzino (2011) explored the energy consumption and aggregate income in Italy and this research focus from the period of 1970-2009 by using time series approach and all the data get from The Total Economy Database (2010). Indeed, the variables are stationary in the first level I(1) and the short run causality shows that there is unidirectional causality running from energy consumption to aggregate income and for long run, there is bidirectional causality between energy consumption and aggregate income. Binh (2011) examined the relationship of energy consumption and economic growth in Vietnam from 1976-

2010. By using ADF and PP tests, all variables are stationary in the first level I (1) and the lag of parameters are selected by AIC. The empirical results show that there is a strong Ganger causality running from economic growth to energy consumption so that the energy conservation policy has little effect on growth.

Altaee et al (2013) explored the relationship of electricity consumption and economic growth in the Kingdom of Bahrain from 1975-2010 and the data is from the World Development Indicator. Indeed, the aim of this paper is to explore the casual relationship between electricity consumption and economic growth in the Kingdom of Bahrain. In this research the author used the econometric techniques such as ADF test and PP test in order to test the unit root test. The optimal lag was selected by using Hannan-Quinn Information Criteria (HQ), Akaike Information Criteria (AIC), and Final Prediction Error (FPE). The empirical results showed that electricity consumption and GDP are cointegrated; in the long run there is a bidirectional causality of electricity consumption and GDP but in the short run there is the unidirectional causality running from electricity consumption to GDP. Ozturk et al (2012) explored the casual relationship of electricity consumption and economic growth in Turkey from 1968-2006. The empirical results, there is both an unidirectional causality running from electricity consumption to economic growth for both short run and long run and electricity consumption plays an important role in economic growth. The aim of this research would like to examine the causality of electricity consumption and economic growth by using ARDL bound testing approach and error correction based causality model.

Souhila et al (2012) examined the relationship of energy consumption and economic growth in Algeria from 1965-2008 by using cointegration and the Ganger causality test. The results revealed that there is unidirectional causality running from GDP to energy consumption so that energy conservation policy has little effect on the economic growth. After testing by using ADF and PP test, all the variables are not stationary in level but stationary in level one I(1). The empirical result showed that there is no cointegration between energy consumption and economic growth in Algeria by using Johansen cointegration test. Apergis et al (2012) tried to examine the relation of energy consumption and economic growth of Romania from 2000-2001. This study used the econometric method of ADF test and the results showed that all

the variables are stationary in the first level. Indeed, there is a long run cointegration of GDP and energy consumption. Kayhan et al (2010) explored the relationship between real GDP and electricity consumption from 2001-2010 and the empirical results showed that there is unidirectional causality running from electricity consumption to economic growth.

There are some differences between the literature reviews above; the author set the GDP per capita as dependent variable and independent variables are electricity consumption, export, capital, and labor. Most of the variables used by the last author used real income, energy consumption, price, electricity consumption, and GDP to estimate the relationships among GDP and those variables. In this research the author tries to estimate the relationship among electricity consumption, export, and economic growth by using Pool Mean Group (PMG) and Mean Group (MG) to estimate the long run and short run relation and Fully Modified Ordinary Least Square (FMOLS) to estimate the cointegaration of each panel data; this method the above literature have not used yet so that this research hope to be the new research to estimate the economic growth by using the advance econometric. The relationship between economic growth and electricity consumption indicated in the various studies do not compare the estimator Pool Mean Group (PMG) and Mean Group (MG) by using Hausman test; the various studies only use the panel ARDL to test the long run and short run correlation. There are few researchers who have used a multivariate framework to estimate the relation of economic growth; Asafu-Adjaye (2000) and Aziz (2011), includes prices addition to electricity consumption and GDP, Ouédraogo (2009), includes investment addition to electricity consumption and GDP, Odiahmbo (2010), includes labor addition to electricity consumption and GDP. In this research the author analyzes the relationship between electricity consumption, export, and economic growth; the author includes export, labor, and capital addition to electricity consumption and economic growth.

2.3 Summarize of Literature Review

Table 2.1 Electricity Consumption Review

Authors	Topics	Variables	Methodology	Result
Asafu-Adjaye, J. (2000)	the relationship between energy consumption and income of four Asia countries	Real income Energy consumption Price	ECM	India and Indonesia (EC => EG) Thailand and The Philippines (EC ⇔ EG)
Wolde-Rufael, Y. (2006)	Electricity consumption and economic growth: a time series experiences 17 African countries	GDP Electricity Consumption	OLS	Six countries have (EG => EC) Three countries (EC=> EG) Three countries EC<=> EG
Odhiambo (2009)	Energy consumption and economic growth nexus in Tanzania	Real GDP per capita Electricity consumption	ARDL bound testing	EC => EG

Table 2.1 (continued)

Authors	Topics	Variables	Methodology	Result
Omotor, D. G. (2008)	Causality between energy consumption and economic growth in Nigeria	Energy consumption GDP	Johansen and Ganger causality test	EC => EG
QiangHou (2009),	the relationship between energy consumption growth and economic growth in China	GDP Electricity consumption	Ganger causality test, ECM	EC ⇔ EG
Ouédraogo, (2009)	Electricity consumption and economic growth in Burkina Faso: A cointegration analysis	GDP Electricity consumption Investment	ARDL	EC ⇔ EG

Table 2.1 (continued)

Authors	Topics	Variables	Methodology	Result
Odiahmbo, N. (2010)	the relationship between electricity consumption and economic growth in Kenya	Electricity consumption Labor GDP	cointegration and ECM	EC => EG
Tang et al (2011),	Exploring the nexus of electricity consumption, economic growth, energy prices, and technology innovation in Malaysia	Electricity consumption GDP	ECM	Income has the positive effects on electricity consumption and price of energy and technology innovation have the negative effects to electricity consumption.

Table 2.1 (continued)

Authors	Topics	Variables	Methodology	Result
Aziz, A. A. (2011),	On the casual links between energy consumption and economic growth in Malaysia	Energy consumption GDP Price	VECM	there is long run cointegration of energy consumption, energy price, and economic growth in Malaysia
Magazzino, C. (2011),	On the relationship between disaggregated energy production and GDP in Italy	Energy consumption GDP	VAR and VEC	En C => income
Binh, P. T. (2011)	Energy consumption and economic growth in Vietnam	Electricity consumption GDP	OLS	EG=> EC

Table 2.1 (continued)

Authors	Topics	Variables	Methodology	Result
Altaee et al (2013)	Electricity consumption-GDP Nexus in Bahrain: A Time Series Analysis	Electricity consumption GDP	OLS	EC <=>GDP
Ali., et al (2012)	Electricity consumption and economic growth nexus: A multivariate analysis for Turkey	Electricity consumption Employment GDP	ARDL Error correction	EC ⇔ EG
Souhila., et al (2012)	Energy consumption and Economic growth in Algeria	Electricity consumption GDP	Ganger causality test	GDP => EC

2.4 Theories

2.4.1 Harrod-Domar Growth Model

Sato, R. (1964) Harrod-Domar is a model that explains about the economic growth by increasing of capital stock; when capital stock increases, output also increases as well. Saving is very important in pushing growth; after saving, it needs to invest in order to increase output. It is generally known that output growth equals exactly the capital growth. For instance, if the capital stock increases 10%, the output increases 10% as well. In a close economy, savings must equal to investment and investment comes from only savings.

$$S=I \tag{1}$$

There are some assumptions of this model such as no changes in price level, net investment= ΔK , and full employment and full capacity utilization.

The basic idea of this model is the increasing of capital is given by savings and the changes of capital equal to investment. Saving is very important in order to improve the capital stock, increasing of capital stock needs an appropriate of saving and investment.

$$\Delta K = I = sY \tag{2}$$

s is saving rate

Y is income

The dynamic of capital stock

$$K_{t+1}= K_t + I_t - \delta K_t \tag{3}$$

K_{t+1} is capital in the year t+1

K_t is capital in the year t

I_t is investment in the year t

δ is the depreciation rate

From equation (3), it shows the capital stock in the period of t+1 which equal to investment minus depreciation of capital in the period of t. The equation (3) implies that the capital in the next period depend on the capital and investment in that period minus the depreciation in that period. In order to improve the capital stock in the next period, there are two kinds of methods. First, government can increase capital stock and investment in the period of time. Second, government also can try to reduce the depreciation; the more government can reduce the depreciation, the more capital stock can increase.

The growth rate of this model is defined as follow

$$g_k = \frac{K_{t+1} - K_t}{K_t} = \frac{I_t - \delta K_t}{K_t} = \frac{sY_t}{K_t} - \delta \qquad (4)$$

The growth rate is $g = \frac{\Delta Y}{Y} = \frac{\Delta K}{K}$ (5)

From equation (4), the growth rate of output is equal to growth rate of capital stock so when it has more capital stock, it will increase more output and has more growth of output. It will be positive growth rate, if the growth rate of capital stock is larger than depreciation; in contrast, if the depreciation is larger than the growth rate of capital stock, it will has negative growth rate. It can have positive growth rate when country can improve the increase of growth rate of capital stock and reduce the depreciate rate.

Equation (5) shows about the growth rate equal to the growth rate of output; it means that the more output increase; it can increase more of output. Furthermore, the growth rate of output equal to growth rate of capital; the more of capital increase, the more of growth rate increase. The growth rate of one country depend on the growth rate of capital stock, the more capacity it can increase capital stock, the more capacity it can improve output.

2.4.2Solow-Swan Model

Dowrick. S et al (2002) Output can depend on capital (K) which the more of capital can produce more output. Output of the production is the sum of consumption and saving rate respected to time.

$$Y(t)= C(t) + I(t) = C(t) + S(t) \quad (6)$$

From equation (6) shows that output depend on consumption and saving; if it has more consumption, it will has less saving and investment.

C(t) is consumption

S(t) is saving

I(t) is investment

Y(t) is output

Model Y=F (K) (7)

There have some assumptions in this model

Labor is fully and efficiently employed

Capital is fully and efficiently employed

A crucial property of this model is diminishing returns to the accumulation of capital. If labor is employed in the same amount without intervention capital so it will diminish the capital stock per labor.

Where $F^{'}(K) > 0, \qquad F^{''}(K) < 0$

Imposing the Inada Condition

$\lim_{k\to\infty} F'(K) = 0 \lim_{k\to 0} F'(K) = \infty$

The key point to increase the growth is to increase capital stock when capital stock increase, output also increase. The rate of new capital accumulation equals to aggregate flow of saving.

$I=sY-\delta K$

Where s is the saving rate

δ is the depreciation rate

K is capital stock

Take derivative respect to time; it gets

$$\dot{K}= sF(K)-\delta K \quad (8)$$

Population Growth

Labor also contribute to growth not only capital stock (K). Output not only depend on capital stock but also labor. Therefore, the production function is

$Y=F(K,L)$

Assumption

Production function is concave

Marginal production of capital is diminishing

Aggregate output constant returns to scale

$$\frac{\partial F}{\partial K}> 0 \ \frac{\partial^2 F}{\partial^2 K} < 0 \quad (9)$$

$$F(\lambda K,\lambda L) = \lambda F(K,L) \quad (10)$$

Output per person is $y=\frac{Y}{L}$, $k=\frac{K}{L}$ capital per labor (11)

$$\text{Therefore } \frac{Y}{L} = F(K, L)/L = F(K/L, 1) = f(k) \quad (12)$$

According to Cobb-douglas production function

$$Y=K^{\alpha}L^{1-\alpha} \qquad 0<\alpha< 1 \quad (13)$$

So, $y=f(k)= k^{\alpha}$

Take derivative K respected to time

$$\dot{k} =sf(k) -(n+\delta)k \quad (14)$$

The increasing of population will decrease the capital stock per labor. The production function is also the same the above production function but just augmented the population growth rate. Indeed, per capital of f(k) will have the same shape as F(K) production function.

In steady state, output and capital stock will keep growing in the rate of population growth rate.

2.4.3 The One-Sector AK Model with an Exhaustible Resource

Schumpeter (1942), according to one-sector of AK growth model, there are some assumptions such as time is continuous, aggregate output depend on technology.

$$Y = AKR^{\phi} \quad (15)$$

Where A is technology

K is current capital flow

R is the current flow of extracted resources

If S is denoted as the current stock of natural resource

$$\dot{S} = -R \quad (16)$$

Solow, R(1957), Capital accumulation according to saving rate

$$\dot{K} = sY - \delta K \quad (17)$$

Where s is saving rate

δ is depreciation rate

K is current capital flow

The growth rate of capital is

$$g = \frac{\dot{K}}{K} = sA - \delta \quad (18)$$

In the long run R will become zero and lead to K to fall to zero in the long run as well. Thus, in the long run $Y = AKR^{\phi}$ must fall to zero. Indeed, in order to sustain growth, R is to be small as goes to infinity so that S and output Y would not vanish in the long run.

2.4.4Schumpeterian Growth with an Exhaustible Resource

Schumpeter (1942)**,** the basic idea of Schumpeterian growth is that technological process and research innovation is used to against the depletion of

exhaustible resources. When research and innovation increase, it can sustain the long run exhaustible resource.

Model

$$Y = L^{1-\alpha} A^{1-\alpha} X^{\alpha} R^{\phi} \quad (19)$$

Where L is labor force employed in production

A is technology progress

X is productivity and intermediate input

R is the current flow of exhaustible resource

It assumed that there are two kind of labor in the production such as manufacturing the final good (L) and research to produce innovation (n) so it can write:

$$L + n = 1 \quad (20)$$

The one intermediate product can produce one manufacturing product so the competitor can sell their product in the price

$$p(x) = \frac{\partial Y}{\partial X} = \alpha L^{1-\alpha} A^{1-\alpha} X^{\alpha-1} R^{\phi} \quad (21)$$

All of firms have the intention to maximize profit so maximize profit is

$$\pi = \max\{p(x)x - x\} \quad (22)$$

Which yield $x = \alpha^{\frac{2}{1-\alpha}} ALR^{\frac{\phi}{1-\alpha}}$ (23)

So $Y = \alpha^{\frac{2\alpha}{1-\alpha}} LAR^{\frac{\phi}{1-\alpha}}$ (24)

Suppose that government can decrease R overtime at an exponential rate, due to

$$\dot{R} = -qR \quad (25)$$

Taking logarithmic derivatives on (1), it gets

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \phi \frac{\dot{R}}{R} = g_a - \phi q \quad (26)$$

Where g_a is the rate of productivity growth

The growth rate of productivity growth get from the labor in innovation which results from research and development so the productivity growth rate is

$$g_a = (\gamma - 1)\lambda n \quad (27)$$

Where λ is the size of innovation

n is the equilibrium amount of R&D

Therefore, the overall economy will sustain in the condition of $(\gamma - 1)\lambda n > \phi q$

$$\text{Or } n > \frac{\phi q}{(\gamma - 1)\lambda} \quad (28)$$

CHAPTER 3

Methodology

3.1 Research Design

There are many literatures related to the determinant factors of economic growth by using empirical methods. This paper set up an economic growth equation by depends on the last empirical research of Lean et al 2010. There are some variables that can determine the economic growth rate of one country; in previous research, the variables that determine the economic growth rate such as energy consumption, electricity consumption, energy price, export, capital, and labor. Therefore, this paper not only introduces the factors that determine the economic growth of eight ASEAN members, but also investigate the coefficient of short run and long run of factors that determine the economic growth of eight ASEAN members.

In addition, this paper uses panel data from two dimensional cross section and time series to study the determinant factors to economic growth of eight ASEAN members. In order to avoid a time series generating spurious regression phenomenon, this paper uses panel unit root test and panel ARDL integration to investigate the relation of long and short run. In addition, Pool Mean Group Estimator (PMG) and Mean Group Estimator (MG) are used to estimate the long run and short run relation of economic growth of eight ASEAN members and Hausman test is introduced to test the best estimator is between PMG and MG. In this way, panel data can be estimated effectively and the regression process reveals some determinant factors of economic growth in long-term equilibrium. Furthermore, the author introduced the Fully Modified Ordinary Least Square (FMOLS) in this paper that estimate the coefficient of each panel group. FMOLS which proposed by Pedroni (2000) is very flexible than other panel data method because it can reduce bias; the t-statistic of FMOLS is allowed to have more flexible alternatives hypothesis.

All in all, this research is based on the theoretical and empirical analysis. As an empirical research, the author will focus on quantitative analysis which the data get from World Development Indicator. In addition, analysis method includes many methods such as panel unit root test which include Levin-Lin-Chu (2002), Im-Peasaran (2003), and Maddala (1999).Last but not least, PMG and MG are used to investigate the long run and short run relation of the variables and other methods.

3.2 Conceptual Framework

The author examines the long run relation among electricity consumption, export, capital, labor, and GDP of eight ASEAN countries by using Pool Mean Group (PMG) and Mean Group (Mean Group) to estimate the long run and short run of those variables. In addition, this research depends on the last research of Lean et al (2010).

Figure 3.1 Conceptual Framework

The research framework and methodology was applied to study "The Relationship of Electricity Consumption, Export, and Economic Growth of ASEAN". The conceptual frameworks of this study are mentioned as above. In this research the author set the input namely as Labor (L), Capital (K), Electricity consumption (EC), and Export (EX). Labor, capital, electricity consumption, and export are the most important factors that can improve the economic growth. Harrod Domar explained

that for economic growth, saving is very important and necessary for output; saving needs to invest in order to create output. In addition, Solow-Swan's model proposed that output can depend on capital (K) and labor (L) but it needs to have appropriate capital and labor to invest. The framework makes it clear that the determinant factors which can determine the economic growth are labor, capital, electricity consumption, and export. The increases of labor, capital, electricity consumption, and export have a positive impact on economic growth.

3.3 Model Specification

$Y_{it}= f (EC_{it}, EX_{it}, K_{it}, L_{it})$

Where Y_{it} is GDP per capita, EC_{it} is electricity consumption per capita, EX_{it} is export per capita, K_{it} is gross capital formation per capita, and L_{it} is labor force

All the variables need to take natural logarithm. The author sets lnGDP as the dependent variable and lnEC, lnEX, lnK, and lnL as the independent variables. Therefore, the model can be written as follows:

$lnGDP_{it} = \beta0 + \beta1lnEC_{it}+\beta2lnEX_{it}+\beta3lnK_{it}+ \beta4lnL_{it} + \varepsilon_{it}$

Where

i and t is the cross section and time series data respectively

$lnGDP_{it}$ is natural logarithm of GDP per capital

$lnEC_{it}$ is natural logarithm of Electricity per capita

lnK_{it} is natural logarithm of gross capital formation

lnL_{it} is natural logarithm of labor

$lnEX_{it}$ is natural logarithm of real export of goods and services

ε_{it} is error term

3.4 Overview of Data Sources

The data sources of this paper are yearly data from eight ASEAN countries and seventy years from 1995-2011. All the data are published in World Development Indicator. All of the variables in this paper have to take the natural logarithm before analysis data and regression model. Also, all variables are used the real value by

(constant 2005 US$) and the data such as GDP, electricity consumption, export, capital formation have to divided to the population of each country in order to get the per capital of those variables. The variable of labor is used the labor force measuring in percentage.

Table 3.1 Variable Definitions and Data Sources

Notation	**Variable name**	**Definition**	**Measuring unit**	**Data Sources**
GDP	Gross Domestic Product	Real Gross Domestic Product per capita	Dollar	World Development Indicator
EC	Electricity consumption	Real Electricity consumption per capita	Dollar	World Development Indicator
EX	Exports of goods and services	Real Exports of goods and services per capita	Dollar	World Development Indicator
K	Gross capital formation	Real Gross capital formation per capita	Dollar	World Development Indicator
L	Labor force	Total labor force participation rate	Percentage	World Development Indicator

3.5 Econometric Methods

3.5.1 Panel Unit Root Tests

Recent literature reviews have used panel unit root test better than other individual time series. There are four types of panel unit root test that will used to test the data namely Levin, Lin and Chu(2002), Im, Persaran and Shin(2003), Fisher Type test using ADF and PP-test (Maddala and Wu(1999)).

3.5.1.1 LLC Test

Levin et al (2002) Panel unit root compounds of the behavior dimension of (T) and cross sectional dimension (N). Levin, Lin and Chu (2002) accept null hypothesis; it means that it has unit root. If T is large, Levin, Lin and Chu test is the appropriate test to propose. In addition, if N is very large and T is very small so that usually panel unit root test can be applied. It seems that the t statistic is computed in pooled fashion. According to Levin et al (2002), the regression model of testing the panel unit toots as below:

Levin et al (2002) model $$DY_{it} = \alpha Y_{it-1} + \sum_{j=1}^{pi} \beta_{it} DY_{it-j} + X_{it}^{*} \delta + \varepsilon_{it} \qquad (29)$$

Where

DY_{it} is the difference term of Y_{it}

Y_{it-1} is panel data

Xit^{*} is exogenous variable in model such as country fixed effects and individual time trend

ε_{it} is the error term

By determining the model (29) the appropriate regression on DY_{it} and the residuls $\hat{e}_{it}$ and $\hat{e}_{it-1}$ from those regression are written equation as follow:

$$\hat{e}_{it} = \Delta y_{it} - \sum_{L=1}^{p_i} \hat{\pi}_{iL} \Delta y_{it-L} - \hat{\alpha}_{mi} d_{mt} \qquad (30)$$

And $$\hat{v}_{it} = \Delta y_{it} - \sum_{L=1}^{p_i} \hat{\pi}_{iL} \Delta y_{it-L} - \hat{\alpha}_{mi} d_{mt} \qquad (31)$$

The equation (30) and (31) divide the regression standard error of $\hat{\sigma}_{it}$ so the equation can be written as follow:

$$\tilde{v}_{it-1} = \frac{\hat{v}_{it-1}}{\hat{\sigma}_{\varepsilon t}} \quad (32)$$

$$\tilde{e}_{it-1} = \frac{\hat{e}_{it-1}}{\hat{\sigma}_{\varepsilon t}} \quad (33)$$

Where $\hat{\sigma}_{\varepsilon t}$ is the estimated error from ADF of the equation (29)

The t-statistic of $\hat{\alpha}$ which is normal distribution, it can be written as follow

$$t_{\alpha}^{*} = \frac{t_{\alpha} - (NT) S_N \hat{\sigma}^{-2} se(\hat{\alpha}) \mu_{mT^*}}{\sigma_{mT^*}} \quad (34)$$

Where se($\hat{\alpha}$) is standard error of $\hat{\alpha}$

$\hat{\sigma}^{-2}$ is error term

S_N is average standard deviation ratio

μ_{mT^*} is adjustment term of mean

σ_{mT^*} is standard deviation

LLC (2002) reveals the null hypothesis and the t statistic as follow:

The null hypothesis of LL is

H_o: null hypothesis as panel data has unit root

H_a: Panel data has no unit root

3.5.1.2 Im, Pesaran and Shin (2003) Test

Im, Pesaran and Shin (2003), this approach would have more flexible that allow for heterogeneous coefficient of $y_{i\,t-1}$. Im-Peasaran-Shin test is more flexible than Levin, Lein and Chu test and Im-Peasaran-Shin is not restrictive; it can allow heterogeneity of coefficient. In addition, Monto Carlos stimulation revealed that the small sample of Im-Peasaran-Shin is better than Levin, Lin and Chu. Let y_{it} is the observation on th i^{th} cross section and time t and Im., et al(2003), the regression model of this model written as follow.

$$\Delta y_{it} = \alpha y_{i,t-1} - \sum_{j=1}^{\rho_i} \varphi_{ij} \Delta y_{i,t-j} - X_{it}' \delta + \varepsilon_{it} \quad (35)$$

T static can be defined as follow:

$$\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_p \qquad (36)$$

t_p is individual t-statistics

Due to $\bar{t} \sim N(0,1)$ and t_{p_i}

We get $(\int_0^1 W_{iZ}\, dW_{iZ}) / [\int_0^1 W_{iZ}^2]$ when t -> ∞ so that the new equation can write as

$$\frac{\sqrt{N}(\frac{1}{N}\sum_{i=1}^{N} t_{iT} - \mu)}{\sigma} \sim N(0,1) \qquad (37)$$

Which μ is mean

σ is variance

If t statistic is bigger than the critical p-value, it rejects the null hypothesis, but if t static is smaller than critical p-value, it accepts the null hypothesis.

The null hypothesis is determined

H_o: $\rho_i = 0$ has unit root, for $\forall$ I

$H_{a:}$ $\rho_i < 0$, for i= 1,2,…,N_1 no unit root

$\rho_i = 0$, for i=N_1+1,…, N no unit root

3.5.1.3 Fisher Type base on Augmented Dickey-Fuller (ADF) and Phillips-Perron Tests

Maddala and Wu (1999) proposed the testing of unit root test of using the Fisher (P_λ) test which is based on combining of p-values of the t statistic for each unit root in each cross section. Let Π_i is the p-value from the i^{th} test and p_i is U [0, 1] and independent. Moreover, it can be noticed that MW test does not require using the same unit root test in each cross section. MW test has λ which is the distribution with 2N distribution of freedom.

$$P_\lambda = -2\sum_{i=1}^{N} \log_e \rho_i \quad (38)$$

Where

P_λ= Fisher (P_λ) panel unit root test

N=all N cross section

P value of Fisher is the value that test the stationary of data from the equation of ADF

$$P = -2 \sum_{i=1}^{N} \ln(p_i) \quad (39)$$

$P \sim \lambda^2(2N)$ is large value so it rejects H_o

The equation of the inverse normal test (Z) and the logit test is

$$Z = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \Phi^{-1}(p_i) \quad (40)$$

Where Φ^{-1} is the inverse of standard normal cumulative distribution function; $0 \leq p_i \leq 1$ and $\Phi^{-1}(p_i) \sim N(0, 1)$ so $Z \sim N(0,1)$

The null hypothesis is determined as

H_0: p_i=1 has unit root

H_a: p_i < 1has no unit root

3.5.2 The MG and PMG Estimators

Edward et al (2007), Autoregressive Distributive Lag (ARDL) is an appropriate approach with the research that has less samples and this approach is very good to analysis the short run and long run relationship in one equation. Indeed, the form of panel dynamic specification of ARDL as follow

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij}^{'} X_{i,t-j} + \mu_i + \varepsilon_{it} \quad (41)$$

Where number of group or cross section is i=1, 2,…, N and Time period t= 1,2, …, T

X_{it} are the vector of explanatory variables

δ_{it} are the coefficient vectors

λ_{it} are scalars, μ_i is the group specific effect

Time trends and other fixed repressors are included

3.5.2.1 MG Estimator

Peasaran (1995) MG estimator permits differing across groups of the intercepts, slope of coefficients, and error variances. The method of Peasaran (2006) developed from Peasaran and Smith (1995) in order to test the panel data and estimate the long run and short run relation. In addition, the panel method proposed by Peasaran (2006) that has small (T) and large (N).

The coefficient of long run parameter estimated by MG estimator

$$\hat{\beta} = N^{-1}\sum_{i=1}^{N}\hat{\beta}_i \tag{42}$$

The variance of Mean group (MG) estimator equation can be written as follow:

$$v(\hat{b}_{MG}) = \frac{1}{N(N-1)}\sum_{i=1}^{N}(\hat{b}_i - \hat{b}_{MG})(\hat{b}_i - \hat{b}_{MG})' \tag{43}$$

The coefficient of long run parameter is estimated by MG estimator.

$$\beta_{1i} = 8^{-1}\sum_{i=1}^{8}\beta_{1i} \qquad \beta_{2i} = 8^{-1}\sum_{i=1}^{8}\beta_{2i} \qquad \beta_{3i} = 8^{-1}\sum_{i=1}^{8}\beta_{3i} \qquad \beta_{4i} = 8^{-1}\sum_{i=1}^{8}\beta_{4i} \tag{44}$$

3.5.2.2 PMG Estimator

Peasaran (1995) the PMG Estimator method of estimation allows short run coefficients, intercepts, and error variance to vary across countries but constrains the long run coefficients to be equal. PMG estimator can allow varies intercept, coefficients, and error variance but it restricts on homogeneity in the long run. Indeed, The PMG Estimator allows estimating the common long run coefficient without making the less plausible assumption of identical dynamics of each country. In addition, the long run parameter estimates and the averaged short run parameter estimate. PMG can estimate the long run and short run of the variable and allow estimating the long run and short run cointegaration regardless it stationary in I(0) or I(1).

$$\Delta y_{it} = \phi_i(y_{i,t-1} - \theta'_i X_{it}) + \sum_{j=1}^{p-1}\lambda^*_{ij}\Delta y_{i,t-1} + \sum_{j=0}^{q-1}\delta^{'*}_{ij}\Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{45}$$

Where $$\phi_i = -(1-\sum_{j=1}^{p}\lambda_{ij}) \tag{46}$$

t=1,2,…., T

y_{it} is dependent variable in countries i at time t

δ_{it} is the coefficient k x 1 vector of explain variables

λ_{it} is scalar term

μ_i is the fixed effect

$$\theta_i=\sum_{j=0}^{q}\delta_{ij}/(1-\sum_{k}\lambda_{ik}),\ \delta_{ij}^{*}=-\sum_{m=j+1}^{q}\delta_{im},\ \lambda_{ij}^{*}=-\sum_{m=j+1}^{p}\lambda_{im} \qquad (47)$$

j=1, 2,…, p-1

θ_i is error speed of adjustment term and if θ_i = 0, there is no long run cointegration

If θ_i > 0, there is no long run cointegration

If θ_i < 0, there has long run cointegration

The long run and short run estimator of Pool Mean Group Estimator (PMG) can be written in the equation as follows:

$$\Delta\ln(GDP)_{it}=\phi_i[(\ln GDP_i)_{t-1}-\beta_1^i(\ln EC_i)_{t-1}-\beta_2^i(\ln EX_i)_{t-1}-\beta_3^i(\ln K_i)_{t-1}$$
$$-\beta_4^i(\ln L_i)_{t-1}]+\sum_{j=1}^{p-1}\gamma_j^i\Delta(y_i)_{t-j}+\sum_{j=1}^{p-1}\delta_j^i\Delta(\ln EC_i)_{t-j}$$
$$+\sum_{j=1}^{p-1}\delta_j^i\Delta(\ln EX_i)_{t-j}+\sum_{j=1}^{p-1}\delta_j^i\Delta(\ln K_i)_{t-j}+\sum_{j=1}^{p-1}\delta_j^i\Delta(\ln L_i)_{t-1}+\mu_i+\varepsilon_{it} \qquad (48)$$

3.5.3 Hausman Test

Pesaran et al (1995) Hausman test is one of the best method to choose to do the judgment amount PMG and MG

The Hausman statistic is distributed as λ^2

$$H=(\hat{\beta}_b-\hat{\beta}_B)'D^{-1}(\hat{\beta}_b-\hat{\beta}_B) \qquad (49)$$

Which $$D=\{V(\hat{\beta}_b)-V(\hat{\beta}_B)\} \qquad (50)$$

$v(\hat{\beta})$ is the variance of coefficient $(\hat{\beta})$

D^{-1} is a generalized inverse

Ho: accept PMG, if probability λ^2> 0.05

Ho: accept MG, if probability $\lambda^2 < 0.05$

Test: Ho: difference in coefficients not systematic

Table 3.2 Standard Method of Panel Unit Root Test

	LLC test	Im-Peasaran-Shin Test	ADF test	PP test
H_o	Variable has unit root			
H_a	Variable has not unit root			
Variables GDP EX EC K L	If test statistics is significant ↓ Reject H_o ↓ Panel data has not unit root ↓ Variable is stationary		If test statistics is not significant ↓ Accept H_o ↓ Panel data hast unit root ↓ Variable is not stationary	

3.5.4 Fully Modified Ordinary Least Square (FMOLS Method)

Pedroni (2000) proposed the new method FMOLS method to estimate the relation of endogenous and exogenous variables by using panel data. FMOLS estimator not only create consistent β coefficient of small sample, but also control the endogenous repressor and correlation. The FMOLS method produces a reliable estimate which there is small sample size and it was original generated by Philips and Hansen and the t-statistic is normal distribution.

The panel regression equation can be written as follow:

$$y_{it} = \alpha_i + \beta_i x_{it} + u_{it} \tag{51}$$

A standard of coefficient of OLS

$$\hat{\beta}_{i,OLS} = (\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)(y_{it} - \bar{y}_i) \tag{52}$$

The method of FMOLS developed from Pedroni (2000) and the individual of β of FMOLS statistic as follow

$$\hat{\beta}_{i,FMOLS} = N^{-1}\sum_{i=1}^{N}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)^2)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)y_{it}^{*} - T\hat{y}_i) \tag{53}$$

$$\text{Where } y_{it}^{*} = (y_{it} - \bar{y}_i) - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}}\Delta x_{it} \tag{54}$$

$$\hat{\gamma}_i = \hat{\Gamma}_{21i} + \hat{\Omega}^{0}_{21i} - \frac{\hat{\Omega}_{21i}}{\hat{\Omega}_{22i}}(\hat{\Gamma}_{21i} - \hat{\Omega}^{0}_{21i}) \tag{55}$$

CHAPTER 4

Empirical Results

4.1 The Results of Panel Unit Root Test

To investigate the relation of electricity consumption, export, and economic growth of eight ASEAN countries, this paper follow the Lean et al, 2010 approach**.**

In this research, there are four steps of methodology which author used to estimate the variables and equations. First, panel unit root test are proposed to test in order to check whether data is stationary; LLC (2002), Im-Peasaran-Shin (2003), and Fisher type are used to test the panel unit root test of variables. Second, the author used Pool Mean Group (PMG) estimator and Mean Group (MG) estimator to estimate the long and short run relation. Then, the author uses the Hausman test to select the best estimate between PMG and MG. Last but not least, Fully Modified Ordinary Least Square (FMOLS) which proposed by Pedroni (2000) is used to estimate of each individual of panel group cross section.

First, this paper determined the determinant factors effect on the economic growth of eight ASEAN countries. In this study, the variables that the author used are lnGDP, lnEX, lnEC, lnK, and lnL. In addition, those variables was tested by the method LLC (2002), Im-Peasaran-Shin (2003), and Fisher-type. In this research the variables can stationary in I (0) or I (1) so that it can test the existence of long run relationship between those variables based on panel ARDL.

Table 4.1 it showed the result of testing panel unit root test by using LLC(2002), Im-Peasaran-Shin (2003), ADF-fisher Chi-square, and PP-fisher Chi-square. The LLC (2002) method indicated that lnGDP, lnEC, lnEX, lnK, and lnL are significance level toaccept the null hypothesis of unit root. Im-Peasaran-Shin (2003) method revealed that lnGDP, lnEC, lnEX, lnK, and lnL are significance level to accept the null hypothesis of unit root. ADF-fisher Chi-square illustrated that lnGDP, lnEX, lnEC, lnK, and lnL are significance level to reject the null hypothesis of unit

root. PP-fisher Chi-square revealed that lnGDP, lnEC, lnEX, lnK, and ln L are significance level accept the null hypothesis of unit root. In conclusion, the results of panel unit root test cannot obtain all the variables have unit root or do not have unit root. Therefore, all the variables have to take the first differentiate based on the four methods of panel unit root test and the result of testing of those variables based on four methods showed in Table 4.1.the LLC(2002) revealed that lnGDP, lnEC, lnEX, lnK, and lnL are significance level to reject the null hypothesis of unit root test. Im-Peasaran-Shin (2003) revealed that lnGDP, lnEX, lnEC, lnK, and lnL are significance level to reject the null hypothesis of unit root test. ADF-fisher Chi-square indicated that lnGDP, lnEC, lnEX, lnK, and lnL are significance level to reject the null hypothesis of unit root test. PP fisher Chi-square revealed that lnGDP, lnEC, lnEX, lnK, and lnL are significance level to reject the null hypothesis of unit root test. Finally, when take first differentiate in all variables then clearly know that all of the variables are stationary in I (1).

4.2 Results of Hausman Test

The regression model on the method PMG and MG estimate the long run correlation among those variables. Hausman test is the standard test to compare coefficient between the regression models. The regression result of Hausman tests the better method between PMG and MG. In the critical assumption of regression model is that the stochastic is not corrected with independence variables. If the true model is heterogeneity, PMG estimator is inconsistent; in this case, MG is consistent. In addition, if the true model is homogeneity, MG is inconsistent; PMG is consistent either.

Edward et al (2007), suggests a test compares the different probability limits of Pool Mean Group Estimator (PMG) and Mean Group Estimator (MG) as a selection criteria for PMG and MG.

Panel ARDL is an approach that is suitable for small sample and does not restrict on the level of stationary; different from Johasen cointegration by using large sample. This approach allows estimating the long run and short run by using one equation.

Panel ARDL model will choose the coefficient estimator between Pool Mean Group Estimator (PMG) and Mean Group Estimator (MG) upon the Hausman test. If the t, Here, the result of Hausman test present in table 4.1 The Hausman test λ^2 statistic is 0.00, which is significance under 0.01 levels. It indicates that Mean Group Estimator is inconsistent, so Pool Mean Group Estimator (PMG) is the better coefficient estimator.

Table 4.1 Results of Hausman Test

	(b) MG	(B) PMG	(b-B) Difference	Sqrt(dig(V_ b-V_B)
lnEC	-0.2543576	0.5077437	-0.7621013	1.37e+20
lnEX	0.8356346	0.4552742	0.3803604	1.76e+20
lnK	-0.0723227	0.3061301	-0.3784528	7.45e+19
lnL	-0.08775474	0 .1747972	-1.052345	9.69e+20

Source: Calculated

b = consistent under Ho and Ha; obtained from xtpmg

B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

Test: Ho: difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 0.00

Prob>chi2 = 1.0000

4.3 Result of PMG

After testing the unit root test by using LLC, Im-Peasaran (2003), ADF, and PP, lnEC, lnEX, lnGDP, lnK, and lnL are stationary in I(1). Pool Mean Group (PMG) which proposed by Peasaran and Smith (2003) are appropriate to estimate to test the long and short run of the correlation. Xtpmg is a new command of Stata to develop to estimate the short and long run relation. Furthermore, the command of xtpmg uses the PMG estimator which is suitable for the nonstationary heterogeneous panels of large number (N) and larger time series (T).

Table 4.2 Result of PMG

D.lnGDP	Coefficient	Standard error	Z	P> Z
Long Run				
lnEC	0.5077437**	0.0171388	29.63	0.000
lnEX	0.4552742**	0.0484056	9.41	0.000
lnK	0.3061301**	0.0287978	10.63	0.000
lnL	0.1747972	0.1802113	0.97	0.332
Short Run				
ΔlnGDP	0.1272511	0.1969705	0.65	0.518
ΔlnEC, D1	0.1851869	0.1428262	1.30	0.195
ΔlnEC, LD	-.0070688	0.0954563	-0.07	0.941
ΔlnEX,D1	0.0874132***	0.0383165	2.28	0.023
ΔlnEX,LD	-0.0001197	0.039297	-0.00	0.998
ΔlnK, D1	0.0034167	0.0656641	0.05	0.959
ΔlnK, LD	-0.0923278	0.0525325	-1.76	0.079
ΔlnL, D1	-0.1283479	1.43003	-0.09	0.928
ΔlnL,LD	1.184013	0.7052894	1.68	0.093
ec	-0.2249168	0.1011799	-2.22	0.026
Constant	-0.2074883	.1047426	-1.98	0.048

Source: Calculated

Note: ** and *** are significance at 1% and 5% respectively, standard errors are in parentheses

Table 4.2 indicated the result of long run relation of those variables by using the method of Pool Mean Group Estimator (PMG). ec is speed of adjustment which indicated the long run relation of those variables. Generally, speed of adjustment reveals negative so it means that those variables have the long run relation. In contrast, if the speed of adjustment is positive, those variables have no long run relation.

The table 4.2 shows the long run relation between electricity consumption and GDP among eight ASEAN countries. The electricity consumption is significance at 0.01 so there is a long run relation between electricity consumption and GDP.

Ouédraogo (2010) revealed that significance at 0.05 when electricity consumption and GDP are used as dependent variables; there is long run relation between electricity consumption and GDP in Burkina Faso. Narayan et al (2008) researched about multivariate casuality between electricity consumption, exports and GDP: Evidence from a panel of Middle Eastern Countries; the empirical results showed that there is long run relation between electricity consumption and GDP of Middle Eastern Countries. Lean (2010) studied about On the dynamic of aggregate output, electricity consumption, and export in Malaysia: evidence from multivariate Granger causality test; the empirical result showed that in the long run there is bidirectional Granger causality between energy consumption and GDP so an increase of electricity consumption in Malaysia can cause an increase in GDP in that country. Therefore, electricity consumption is the base input to improve the economic growth of Malaysia. Ozturk et al (2011) showed that by using ARDL model based on SBC, the results show that there is a long run relation between electricity consumption per capita and real GDP per capita significance at 0.01 for Egypt and Oman, and significance at 0.001 for Israel and Saudi Arabia. Hamdi et al (2014), the author researched about the nexus between electricity consumption and economic growth in Bahrain; by using ARDL approach, the empirical shows that electricity consumption is significance at 0.01 and electricity have the long run relation with economic growth. Therefore, electricity consumption can contribute to the growth of Bahrain and electricity consumption is very crucial for Bahrain economy. Mutascu (2011) studied about revising the relationship between electricity consumption, capital, and economic growth: cointegration and causality analysis in Romania; the author employed the ARDL approach to estimate the relation between electricity consumption and economic growth. The empirical result revealed that there was long run relation between electricity consumption and economic growth in Romania. All in all, electricity consumption plays crucial role in economy and especially ASEAN which most of countries are developing countries so electricity plays an important role to contribute to economic growth in ASEAN. Because of the demand of energy especially electricity, there is an effort of improving in this sector for most of ASEAN leader. The Least Developed Countries (LDC) has improved the ability of energy supply in order to complete the demand of the energy of those countries. Vietnam is

also the country that improves of investing of energy because the government has put into use of improving of energy. In 2011 Vietnam invested $ 2.77 billion in energy sector which contributed from private sector in order to pushing the energy supply in that country and $0.16 billion in 2012. Malaysia and Indonesia also improved the investment in energy by contributing from private sectors. In 2011 there were $0.24 billion and $0.366 billion for Malaysia and Indonesia respectively. Furthermore, in 2012 Malaysia increased more investment in energy to fulfill the demand in its own country from $0.24 billion to $4.38 billion which increased 18.25%; the positive growth of energy power, it reveals that not only Malaysia but also other ASEAN members need much of energy and electricity to develop its own country. All in all, there is a positive sign of growth in investing in energy and it is the factor that can facilitate and push the economic growth of those countries. Because of the future expectation of the demand of electricity consumption, there is an increase of dam in some of ASEAN countries to fulfill the demand of the population and production. Electricity will have the highest of energy consumed among 6.4% per annum. Furthermore, the increasing of hydropower is growing rapidly in order to produce the energy to fulfill the demand of people and production; the Great Mekong Sub region will demand of more energy from hydropower which the growth rate is 7.1%. In addition, Geothermal energy will develop in order to fulfill the energy demand which the growth of 5.2% of annual growth in Philippines and Indonesia. There are some renewable energy, biofuel, and nuclear energy target for some countries in ASEAN. In order to fulfill the huge among of energy demand of electricity, most of ASEAN has tried to find out the ways to solve the energy problems. Cambodia will produce solar photovoltaic 1.5MW, Biomass Gasification 87 KW, and Micro hydro 500 KW. For Indonesia there is a mix of increase of energy production such as 5% of biofuels, 5% of geothermal, 2.6% of hydro, 0.03% of wind, and 0.74% of biomass. Malaysia also increases the energy production to installed renewable energy by 2030; 1340 MW Biomass, 410 MW Biogas, 490 MW Mini-hydro, and 854 MW Solar. Target for Philippine, it needs to increase 1,500 MW of new geothermal, 2,100 MW of new hydro capacity, 950 MW of new win capacity, 71 MW for new Solar capacity, 102 MW of new Biomass capacity. In 2030 Vietnam will produce 2,100 MW wind, 2,400 MW small hydro, and 400 MW biomass.

In addition, the table 4.2 shows the long run relation between export and GDP among eight ASEAN countries. The export is significance at 0.01 so there is a long run relation between export and GDP of ASEAN. If there is an increase of export, there is an increase of GDP per capita because of the positive relation of export. Lean (2010) studied about on the dynamic of aggregate output, electricity consumption, and export in Malaysia: evidence from multivariate Granger causality test; the empirical result revealed that at 0.01 significance export cause Ganger causality to GDP. The increase of export can cause an increase of GDP of Malaysia. The hypothesis of export led growth claim to the world that Malaysia is a country that export is an engine to improve the economic growth of this country. Furthermore, it shows the long run relation between capital and GDP among eight ASEAN countries. Capital is significance at 0.01 so there is a long run relation between capital and GDP of eight ASEAN countries. Shahbaz et al (2012) the research studied about the dynamic of electricity consumption and economic growth: A revisit study of their causality in Pakistan; the empirical result shows that there are both long and short run relation between capital and GDP of Pakistan. The results imply that capital is important production factor for Pakistan and this study also comparable with Yuan and Erbaykal. Hamdi et al (2014) researched the nexus between electricity consumption and economic growth in Bahrain; ARDL approach was used to estimate the long run and short run of electricity consumption and economic growth in Bahrain. The empirical of this research revealed that there is significance at 0.001; therefore, there is a long run relation between capital and economic growth in Bahrain. ASEAN Economic Community (AEC) is a starting point to integrate economic cooperation among ASEAN countries in this region. It believed that capital flow is very important to develop the region and FDI is the key to bring more capital flow and investment to that region. The composition of capital flow in developing countries changed over time and the share of debt of developing declined overtime and the trend of reversed after the ASEAN financial crisis in 1997. The share of capital flow has increased rapidly for emerging market and developing countries; capital account liberalization is very important to improve growth and to strengthen the economic integration of ASEAN region. The free flow of capital is the significant point of economic integration of ASEAN region; the marginal flow of capital in rich countries is less

than developing countries so that the capital flow will flow to the emerging market. Furthermore, there have some benefits of capital flow to economy as a whole; capital flow eased the domestic saving and pushed the economic growth. Some of ASEAN government improved of raising investment rate indirectly by providing more resources; capital flow is the essential to success the economic integration of the region. Table 4.14 it shows the composition of gross inflows to ASEAN, emerging market, and other developing countries. The table shows the gross inflow to ASEAN from 1980 to 2006; from 1980-1984 the gross inflow to ASEAN was $23.1 billion and 1985-1989 was $35.1 billion. There was a positive increasing of gross inflow $51.3 billion, $75.6 billion, $89.9 billion, $113.2 billion of 1990-1994, 1995-1999, 2000-2004, and 2000-2006, respectively. The positive flow of gross inflow revealed that ASEAN had the positive to growth and the capital flow to this region eased the domestic saving and improved the economic growth. The share of FDI in ASEAN also significance to increase and the trend of growth; the share of FDI was $13 billion, $13.6 billion, $27.3 billion, $35 billion, $25.9 billion, and $25.7 billion, from 1980-1984, 1985-1989, 1990-1994, 1995-1999, 2000-2004, and 2000-2006, respectively. The positive and increase of inflow of FDI shows that foreigners are looking for investment opportunity in this region. To success the economic integration of ASEAN Economic Community (AEC), private sector is also the key to improve the free flow of capital so that most of ASEAN government has to work with private sector to bring more capital inflow to this region. In addition, there was decreasing of debt of ASEAN countries so that it can reveal that ASEAN has the ability to develop its own country; the saving rate and FDI increased rapidly which was the sign of positive growth of this region. The capital flow and capital movement in the future is very important so that increasing of capital can contribute to economic growth of that region.

Table 4.2 shows the long run relation between Labor and GDP among eight ASEAN countries. The empirical result shows that there was not significance of labor and GDP. The result shows that labor reject H_0; therefore, there is no long run relation between labor and GDP of eight ASEAN countries. The reason that labor cannot have long run relation because the quality of education and human resources of the ASEAN countries is not quite the same so that the gap between the quality of human

resources and education in each ASEAN countries is also the issue that cause the labor cannot cause long run relation with economic growth.

The table 4.2 shows the short run relation of electricity consumption and GDP of eight ASEAN countries. The result shows that null hypothesis reject H_o so that there is no short run relation between electricity consumption and GDP. Ozturk et al (2011) there is no relationship between electricity consumption and economic growth in most of the MENA countries so there electricity consumption cannot explain GDP in MENA countries. The energy conservation has little impact economic growth of MENA countries. In contrast to the research of Shahbaz et al (2012) the empirical research shows that there are both short and long run relation of electricity consumption and economic growth for Pakistan. Electricity consumption plays an important role in Pakistan and electricity consumption is the engine that can improve the economic growth of Pakistan. All in all, in short run electricity consumption cannot contribute the economic growth of ASEAN countries because ASEAN depend on the import of oil a lot and has less hydro power dam to produce more electricity which can contribute to the economic growth of this region. Hamdi et al (2014) studied about the nexus between electricity consumption and economic growth in Bahrain; the empirical result shows that in short run there is no correlation between electricity consumption and economic growth in Bahrain. There are some reasons that electricity consumption cannot explain GDP in the short run; there is an inequality of GDP distribution among the ASEAN members; the gap between the rich and poor country. In addition, the political problems in some countries which caused the obstacles to develop country; in 2013 Cambodia got the political deadlock which delayed some of development plan in this country. Meanwhile, Thailand challenges the political problems in this year as well; the conflict of South China Sea pushed to some conflict between China and some countries in ASEAN such as Vietnam, Philippines, and Brunei. Those problems are the obstacles to develop ASEAN region.

Table 4.2 shows the short run relation of export and GDP of eight ASEAN countries. The result shows that there is significance at 0.05 of export. The increase of export can improve the economic growth of ASEAN. Export plays very important in this region because most of ASEAN countries depend on export to growth. When there is a short in economy, export has the relation with the GDP. The last period of export

EX_{it-1} can explain the variable of GDP and there is a positive relation between export and GDP.

Table 4.2 shows the short run relation of capital and GDP of eight ASEAN countries. The result shows null hypothesis reject H_o so in short run there is no relation between capital and GDP. Therefore, capital cannot contribute to GDP in the short run. There has some problems and obstacle that capital cannot contribute in the long run because most of ASEAN countries are developing countries so that the law and regulation is not so strict and the accountability in those are not widely open so that corruption emerge everywhere in those countries. The lack of regulation and law cause FDI and investment cannot contribute much to the development.

Table 4.2 shows the short run relation of labor and GDP of eight ASEAN countries. The null hypothesis is reject H_o so there is no short run relation between labor and GDP of ASEAN. In this research, there is no both short and long run relation between labor and GDP of eight ASEAN countries. The labor cannot explain the relation of GDP because of some reasons that human development is not equal from one country to another so that labor cannot contribute to explain the economic growth. In short run the variable of electricity consumption is not significance; it means that in short run electricity consumption cannot explain the variable of GDP.

The error correction mechanism or speed of adjustment revealed -0.22; the speed of adjustment revealed negative sign so it means that there are long and short run among those variables. In addition, ECM is -0.22 and significance so that if there are any short in the economy it adjusted that 22% that can move to the equilibrium. When growth is high and below the equilibrium level, it adjusts by approximately 22% within the first year in order to ensure the equilibrium level. Nnaji et al (2013) the research revealed that ECM is -0.97 so it has long run relation when there has something shock in the economy. The speed of adjustment in this study is very high and the result indicated that the change in electricity consumption had significance impact on economic growth in Nigeria. Odiahmbo (2010) the author research about the electricity consumption, labor force participation rate and economic growth in Kenya: an empirical investigation; the empirical research of this study revealed that ECM is -0.59; therefore, there are both short and long run causality running from electricity consumption to economic growth. Electricity consumption is very

important for improving economy in Kenya. If there was any shock in Kenya, it will move to equilibrium by 59% of expectation. All in all, changes in electricity consumption, export, capital, and labor impact to the real GDP in ASEAN region.

4.4 Result of Short –run Relationship based on PMG

Table 4.3 Result of Short-run Relationship in Cambodia

Variable	Coef	Std.Error	Z-statistic	P> $\|Z\|$
Cambodia				
$\Delta \ln ec_{i,t-1}$	.0189997	.0659704	0.29	0.773
$\Delta \ln ec_{i,t-2}$	.0524101	.049349	1.06	0.288
$\Delta \ln ex_{i,t-1}$	.2400039*	.0528543	4.54	0.000
$\Delta \ln ex_{i,t-2}$	.1385861*	.05204	2.66	0.008
$\Delta \ln k_{i,t-1}$	-.0344696	.0523952	-0.66	0.511
$\Delta \ln k_{i,t-2}$	-.0349683	.0585817	-0.60	0.551
$\Delta \ln l_{i,t-1}$	6.492321*	1.697573	3.82	0.000
$\Delta \ln l_{i,t-2}$	2.752095	2.758593	1.00	0.318
$Ec_{i,t-1}$	.0371279***	.0195297	1.90	0.057

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the quilibrium or back to the long-run equilibrium relationship

Table 4.3 shows the short run relationship in Cambodia by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.3. The error correction mechanism (ECM) revealed the coefficient of 0.03. Therefore, it indicated that in short run there are not correlation among electricity consumption, export, labor, and capital with GDP in Cambodia.

Table 4.4 Result of Short-run Relationship in Thailand

Variable	Coef	Std.Error	Z-statistic	P> $\lvert Z \rvert$
Thailand				
$\Delta \ln ec_{i,t-1}$	1.117491*	.2787036	4.01	0.000
$\Delta \ln ec_{i,t-2}$	.2721835**	.112724	2.41	0.016
$\Delta \ln ex_{i,t-1}$	-.0562966	.0537003	-1.05	0.294
$\Delta \ln ex_{i,t-2}$	.0532255	.0450697	1.18	0.238
$\Delta \ln k_{i,t-1}$	.1121779*	.0348961	3.21	0.001
$\Delta \ln k_{i,t-2}$	-.3232522*	.1243368	-2.60	0.009
$\Delta \ln l_{i,t-1}$	-.8302944	.6752164	-1.23	0.219
$\Delta \ln l_{i,t-2}$	.5126081	.4510244	1.14	0.256
$Ec_{i,t-1}$	-.1157487*	.0350643	-3.30	0.001

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the quilibrium or back to the long-run equilibrium relationship

Table 4.4 shows the results of short run relationship in Thailand by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.4. The table 4.4 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.115 significant at 0.01. Nnaji et al (2013) the research revealed that ECM is -0.97 so it has long run relation when there has something shock in the economy If there was any shock , it will move to equilibrium by 97% of expectation. From table 4.4 shows that the coefficient of electricity consumption $lnec_{i,t-1}$ and $lnec_{i,t-2}$ are 1.11 and 0.27 significant at 0.01 and 0.05. If there is an increasing of 1.11 of electricity consumption in the period of t-1, it will increase GDP in Thailand 0.01. Mutascu (2011) studied about revising the relationship between electricity consumption, capital, and economic growth:

cointegration and causality analysis in Romania; the author employed the ARDL approach to estimate the relation between electricity consumption and economic growth. The empirical result revealed that there was long run relation between electricity consumption and economic growth in Romania. Electricity consumption plays an important role in Thai economy so that Thai government should pay more attention on electricity production. In addition, the coefficient of $lnk_{i,t-1}$ and $lnk_{i,t-2}$ are 0.11 and -0.32 significant at 0.01. The increase 0.11 of capital $lnk_{i,t-1}$ can increase 0.01 of GDP; therefore, capital is very important in Thailand because Thailand is still the developing country so that the capital inflow is very important to improve the economic growth in Thailand.

Table 4.5 Result of Short-run Relationship in Vietnam

Variable	Coef	Std.Error	Z-statistic	P> $\|Z\|$
Vietnam				
$\Delta \ln ec_{i,t-1}$	.1506964***	.0861909	1.75	0.080
$\Delta \ln ec_{i,t-2}$	.156819	.1064179	1.47	0.141
$\Delta \ln ex_{i,t-1}$	.0913036*	.026943	3.39	0.001
$\Delta \ln ex_{i,t-2}$	.0366662	.052375	0.70	0.484
$\Delta \ln k_{i,t-1}$	.0345028	.0644018	0.54	0.592
$\Delta \ln k_{i,t-2}$	-.1223807**	.0531868	-2.30	0.021
$\Delta \ln l_{i,t-1}$	3.228633***	1.877769	1.72	0.086
$\Delta \ln l_{i,t-2}$	-2.228613	2.585136	-0.86	0.389
$Ec_{i,t-1}$	-.0182756**	.0064676	-2.83	0.005

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the quilibrium or back to the long-run equilibrium relationship

Table 4.5 shows the results of short run relationship in Thailand by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.5. The table 4.5 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.18 significant at 0.01; therefore, if there has shock in the economy, it will move to equilibrium by 18% of expectation. Odiahmbo (2010) the author research about the electricity consumption, labor force participation rate and economic growth in Kenya: an empirical investigation; the empirical research of this study revealed that ECM is -0.59; therefore, there are both short and long run causality running from electricity consumption to economic growth. Electricity consumption is very important for improving economy in Kenya. If there was any shock in Kenya, it will move to equilibrium by 59% of expectation. Table 4.5 shows that the coefficient of $lnec_{i,t-1}$ is 0.15 significant at 0.1; there has the relationship between electricity consumption and GDP in short run. The increase of 0.15 of electricity consumption can increase of 0.01 of GDP in Vietnam in short run. Besides that, the coefficient of $lnex_{i,t-2}$ is 0.09 significant at 0.01; export has the relationship with GDP of Vietnam in short run. The increase of 0.09 of export can increase of 0.01of GDP in Vietnam. Moreover, the coefficient of $lnk_{i,t-2}$ is -0.12 significant at 0.05 and the increase of capital has the negative growth to GDP in Vietnam. The coefficient of $lnl_{i,t-1}$ is 3.22 significant at 0.1 so that the increase of labor has the positive relation to GDP in Vietnam. Binh (2011) examined the relationship of energy consumption and economic growth in Vietnam from 1976-2010. The empirical results show that there is a strong Ganger causality running from economic growth to energy consumption so that the energy conservation policy has little effect on growth.

Table 4.6 Result of Short-run Relationship in Malaysia

Variable	Coef	Std.Error	Z-statistic	P> $\lvert Z \rvert$
Malaysia				
$\Delta \ln ec_{i,t-1}$	-.1479063*	.0563897	-2.62	0.009
$\Delta \ln ec_{i,t-2}$	-.0292441	.0443574	-0.66	0.510
$\Delta \ln ex_{i,t-1}$	.1841604*	.04156	4.43	0.000
$\Delta \ln ex_{i,t-2}$	-.237849*	.0745861	-3.19	0.001
$\Delta \ln k_{i,t-1}$	.1684692*	.021716	7.76	0.000
$\Delta \ln k_{i,t-2}$	-.1725413*	.0489261	-3.53	0.000
$\Delta \ln l_{i,t-1}$	-1.409994*	.2976551	-4.74	0.000
$\Delta \ln l_{i,t-2}$	.9579629**	.4169095	2.30	0.022
$Ec_{i,t-1}$	-.1052294***	.0579797	-1.81	0.070

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the quilibrium or back to the long-run equilibrium relationship.

Table 4.6 shows the results of short run relationship in Malaysia by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.6. The table 4.6 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.10 significant at 0.1; therefore, if there has shock in the economy, it will move to equilibrium by 10% of expectation. Table 4.6 reveals that the coefficient of $lnec_{i\ t-1}$ is -0.14 significant at 0.01; electricity consumption has the negative relation to GDP in Malaysia. Besides that, the coefficient of $lnex_{i,\ t-1}$ is 0.18 significant at 0.01; there is a positive relation between export and GDP in Malaysia. In addition, table 4.22 reveals that $lnk_{i,\ t-1}$ is 0.16 significant at 0.01; there is a positive relation between capital and GDP in Malaysia. The increase of 0.16 of capital can increase 0.01 of GDP in Malaysia

because the capital inflow is very important to economic growth in Malaysia. The coefficient of $lnl_{i,\,t\,-1}$ is -1.4 significant at 0.01; there is the negative relation between labor and GDP in Malaysia. Hamdi et al (2014) researched the nexus between electricity consumption and economic growth in Bahrain; ARDL approach was used to estimate the long run and short run of electricity consumption and economic growth in Bahrain. The empirical of this research revealed that there is significance at 0.001; therefore, there is a long run relation between capital and economic growth in Bahrain. Ozturk et al (2011) there is no relationship between electricity consumption and economic growth in most of the MENA countries so there electricity consumption cannot explain GDP in MENA countries. The energy conservation has little impact economic growth of MENA countries.

Table 4.7 Result of Short-run Relationship in Philippines

Variable	Coef	Std.Error	Z-statistic	P> $\lvert Z \rvert$
Philippines				
$\Delta \ln ec_{i,t-1}$	.0286751	.0320513	0.89	0.371
$\Delta \ln ec_{i,t-2}$	-.2302306*	.0342258	-6.73	0.000
$\Delta \ln ex_{i,t-1}$	-.0027192	.0185547	-0.15	0.883
$\Delta \ln ex_{i,t-2}$	-.0674507*	.009986	-6.75	0.000
$\Delta \ln k_{i,t-1}$	-.2337122*	.0229307	-10.19	0.000
$\Delta \ln k_{i,t-2}$	-.1448917*	.0202946	-7.14	0.000
$\Delta \ln l_{i,t-1}$	.5079757*	.0812	6.26	0.000
$\Delta \ln l_{i,t-2}$	.2600745*	.0425093	6.12	0.000
$Ec_{i,t-1}$	-.6340758*	.035071	-18.08	0.000

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the quilibrium or back to the long-run equilibrium relationship.

Table 4.7 shows the results of short run relationship in Philippines by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.7. The table 4.7 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.63 significant at 0.01. If there has any shock in economy, it will move to equilibrium in 63% of expectation. The coefficient of $lnec_{i,\ t\ -2}$ is -0.23 significant at 0.01 so that there is the negative relation between electricity consumption and GDP in Philippines. In addition, the table 4.7 reveals that the coefficient of $lnex_{i,\ t\ -2}$ is -0.06 significant at 0.01. There are negative relation between export and GDP in Philippines in short run. Besides that, the coefficient of $lnk_{i,\ t\ -\ 1}$ is -0.23 significant at 0.01 so that there is the negative relation between capital and GDP in Philippines in short run. The coefficient of $lnl_{i,\ t-1}$ is 0.50 significant at 0.01; labor has the positive relation with GDP in Philippines. If there is an increase of 0.50 of labor, it can increase of 0.01 of GDP in Philippines in short run.

Apergis et al (2012) tried to examine the relation of energy consumption and economic growth of Romania from 2000-2001; there is a long run cointegration of GDP and energy consumption. Kayhan et al (2010) explored the relationship between real GDP and electricity consumption from 2001-2010 and the empirical results showed that there is unidirectional causality running from electricity consumption to economic growth.

Table 4.8 Result of Short-run Relationship in Singapore

Variable	Coef	Std.Error	Z-statistic	P> $\|Z\|$
Singapore				
$\Delta \ln ec_{i,t-1}$	.3479553**	.1701585	2.04	0.041
$\Delta \ln ec_{i,t-2}$	.3423158**	.1578108	2.17	0.030
$\Delta \ln ex_{i,t-1}$	.1669897	.1117993	1.49	0.135
$\Delta \ln ex_{i,t-2}$	.01926	.0773667	0.25	0.803
$\Delta \ln k_{i,t-1}$	-.2477371*	.0912744	-2.71	0.007
$\Delta \ln k_{i,t-2}$	-.0961418**	.0393537	-2.44	0.015
$\Delta \ln l_{i,t-1}$	-.3013634	.3060974	-0.98	0.325
$\Delta \ln l_{i,t-2}$	1.583965*	.3836713	4.13	0.000
$Ec_{i,t-1}$	-.7183119**	.308552	-2.33	0.020

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively
The examination results according to -2< ECM(-1) < 0 are statistically significant
Adjustment of short run refers to the speed of adjustment in the quilibrium or back to the long-run equilibrium relationship.

Table 4.8 shows the results of short run relationship in Singapore by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.8. The table 4.8 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.71 significant at 0.05. If there has any shock in economy, it will move to equilibrium in 71% of expectation. The table 4.8 reveals that the coefficient $lnec_{i,\,t-1}$ is 0.34 significant at 0.05; there is positive relation between electricity consumption and GDP in Singapore. The increase of 0.34 of electricity consumption can increase 0.01 of GDP in Singapore in short run. In addition, the table 4.24 reveals that the coefficient of $lnk_{i,\,t-1}$ is -0.24 so that there is a negative relation between capital and GDP in Singapore. Besides that, the

coefficient of $lnl_{i,\,t-2}$ is 1.58 significant at 0.01; there is positive relation between labor and GDP in Singapore.

Table 4.9 Result of Short-run Relationship in Indonesia

Variable	Coef	Std.Error	Z-statistic	P> $\lvert Z \rvert$
Indonesia				
$\Delta \ln ec_{i,t-1}$	-.032971	.1509124	-0.22	0.827
$\Delta \ln ec_{i,t-2}$	-.4612381**	.1822116	-2.53	0.011
$\Delta \ln ex_{i,t-1}$	-.031177	.0448379	-0.70	0.487
$\Delta \ln ex_{i,t-2}$	.0282972	.0462726	0.61	0.541
$\Delta \ln k_{i,t-1}$	.2816783*	.0612248	4.60	0.000
$\Delta \ln k_{i,t-2}$	.2001263***	.1149566	1.74	0.082
$\Delta \ln l_{i,t-1}$	-1.110265	.8106367	-1.37	0.171
$\Delta \ln l_{i,t-2}$	.9592506	.7418414	1.29	0.196
$Ec_{i,t-1}$	-.0787232***	.0298344	-2.64	0.008

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the equilibrium or back to the long-run equilibrium relationship.

Table 4.9 shows the results of short run relationship in Indonesia by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.9. The table 4.9 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.78 significant at 0.01. If there has any shock in economy, it will move to equilibrium in 78% of expectation. The table 4.9 reveals that the coefficient of $lnec_{i,\,t-2}$ is -0.46 significant at 0.05; there are negative relation between electricity consumption and GDP in Indonesia. Besides that, the coefficient of capital is 0.28 significant at 0.01; there are the positive relation

between capital and GDP. The increase of 0.28 of capital can increase of 0.01 of GDP in Indonesia. Therefore, capital is very important to improve the economic growth in Indonesia.

Table 4.10 Result of Short-run Relationship in Brunei

Variable	Coef	Std.Error	Z-statistic	P> $\lvert Z \rvert$
Brunei				
$\Delta \ln ec_{i,t-1}$	-.0014446	.1719623	-0.01	0.993
$\Delta \ln ec_{i,t-2}$	-.1595659	.1513189	-1.05	0.292
$\Delta \ln ex_{i,t-1}$	.1070412	.0937033	1.14	0.253
$\Delta \ln ex_{i,t-2}$	.0283072	.1797465	0.16	0.875
$\Delta \ln k_{i,t-1}$	-.0535755	.0723052	-0.74	0.459
$\Delta \ln k_{i,t-2}$	-.044573	.0408659	-1.09	0.275
$\Delta \ln l_{i,t-1}$	-7.603796	6.159223	-1.23	0.217
$\Delta \ln l_{i,t-2}$	4.674763	4.389127	1.07	0.287
$Ec_{i,t-1}$	-.1660978	.2501943	-0.66	0.507

Note: *, **, and *** are significant at 1%, 5%, and 10%, respectively

The examination results according to -2< ECM(-1) < 0 are statistically significant

Adjustment of short run refers to the speed of adjustment in the equilibrium or back to the long-run equilibrium relationship.

Table 4.10 shows the results of short run relationship in Indonesia by using Pool Mean Group estimation (PMG); the results of short-run relationships of macroeconomic forces for each of the hypothesized relationship are reported in Table 4.10. The table 4.10 shows the results of the short run ECM selected based on ARDL approach to cointegration; the coefficient of ECM reveals -0.16 and not significant. Therefore, in short run there are no relation among electricity consumption, capital, export, and labor with GDP.

4.5 Result of MG Test

After testing the unit root test by using LLC, Im-Peasaran (2003), ADF, and PP, lnEC, lnEX, lnGDP, lnK, and lnL are stationary in I(1). MG estimator permits differing across groups of the intercepts, slope of coefficients, and error variances. The method of Peasaran (2006) developed from Peasaran and Smith (1995) in order to test the panel data and estimate the long run and short run relation.

Table 4.11 Result of MG estimator

D.lnGDP	Coefficient	Stadard Error	Z	P>Z
Long Run				
lnEC	-.2543576	.3393941	-0.75	0.454
lnEX	0.8356346	.4342329	1.92	0.054
lnK	-00723227	.1839167	-0.39	0.694
lnL	-.8775474	2.393035	-0.37	0.714
Short Run				
ΔlnGDP,LD	0.1595172	1.483722	0.11	0.914
ΔlnEC, D1	0.8383757	0.9088633	0.92	0.356
ΔlnEC, LD	-.1362366	0.1261814	-1.08	0.280
ΔlnEX, LD	0.6522327	0.6518214	1.00	0.317
ΔlnEX, D1	0.2482351	0.3608984	0.69	0.492
ΔlnK, D1	-0.361967	0.4363339	-0.83	0.407
ΔlnK,LD	-0.2586194	0.1399613	-1.85	0.065
ΔlnL, D1	4.760917	5.472607	0.87	0.384
ΔlnL, LD	-2.372877	4.126314	-0.58	0.565
ec	0.4387853	2.459787	0.18	0.858
Constant	4.056541	4.559867	0.89	0.374

Source: Calculated

The result of MG estimator shows that the speed of adjustment of ec is 0.43; it means that there is not long run correlation among lnEC, lnEX, lnK, lnL. After testing the MG estimator, the speed of adjustment shows is positive so that there is no long

run and short run by using MG estimator. After selection coefficient between PMG and MG upon Hausman test, the results revealed that PMG is the better coefficient estimator.

Table 4.12 Result of Panel Unit Root Tests Based on 4 Method Tests for Variables

Method	GDP (lnGDP)		Electricity consumption (lnEC)	
	Level	First difference	Level	First difference
Null Hypothesis: unit root (common unit root process)				
LLC	2.4413	-14.1343**	-2.6820***	-6.6840 **
Im-Peasaran-Shin	4.6693	-9.2327**	0.7409	-6.1366**
ADF(Chi - square)	16.7758	51.0132**	22.4422	53.0987**
PP(Chi-square)	1.7362	79.7629**	24.1480	125.4261**

Source: Calculated

Denote *** and ** denote statistical significance at 5% and 1%, respectively

Table 4.12 (Continued)

Method	Export (lnEX)		Capital (lnK)		Labor (lnL)	
	Level	First difference	Level	First difference	Level	First difference
Null Hypothesis: unit root (common unit root process)						
LLC	-4.6584**	-10.2011**	-0.5027	-6.1190**	-3.6149**	-3.1184**
Im-Peasaran-Shin	-0.3486	-8.8421**	-0.1476	-5.1414**	-2.5903***	-4.8963**
ADF(Chi - square)	37.1597***	43.9779**	40.1343**	64.0016**	57.1519**	55.8986**
PP(Chi-square)	11.9714	172.5229**	11.6213	106.1635**	9.8933	73.3152**

Source: Calculated

Denote *** and ** denote statistical significance at 5% and 1%, respectively

Table 4.13 Composition of Gross inflows to ASEAN, Emerging Markets, and other Developing Countries

Gross inflows	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2000-2006
ASEAN (in billions of US)	23.1	35.1	51.3	75.6	89.9	113.2
Share of FDI	13.0	13.6	27.3	35	25.9	25.7
Share of Equity and Portfolio	4.5	3.4	6.9	8.2	5.7	9.3
Share of Debt	82.5	82.9	65.8	56.8	68.4	65
Emerging market	66	60	194	328	288	N/A
Share of FDI	15.5	27.3	24.4	40.7	48.6	N/A
Share of Equity and Portfolio	1.5	3.4	11.7	11	12	N/A
Share of Debt	83	69.3	63.9	48.2	39.3	N/A
Other developing Countries	6	4	7	13	16	N/A
Share of FDI	15.1	17.2	27.7	40.9	44.2	N/A
Share of Equity and Portfolio	1.1	0.6	0.5	0.5	0.4	N/A
Share of Debt	83.8	82.2	71.8	58.6	55.4	N/A

Source: ASEAN data, IMF Financial Statistics, IMF Balance of Payment Statistics and International Investment Position (IIP)

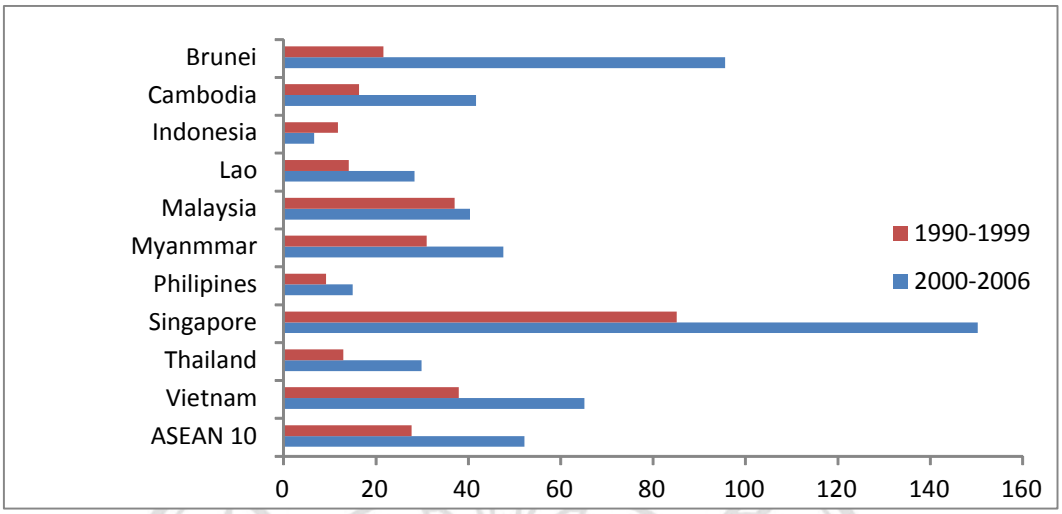

Figure 4.1 FDI as a share of gross domestic product (in %)

Source: IMF-World Economic Outlook, 2007; UNCTAD FDI Statistic

Table 4.14 The Result of PMG and MG

Independent Variables	PMG	MG
Constant	-0.2074883***	4.056541
	(0.1047426)	(4.559867)
lnEC	0.0171388**	.3393941
	(0.5077437)	(-.2543576)
lnEX	.0484056**	0.4342329
	(0.4552742)	(.8356346)
lnK	.0287978**	0.1839167
	(0.3061301)	(-.0723227)
lnL	.1802113	2.393035
	(.1747972)	(-0.8775474)
ec	.1011799***	2.459787
	(-0.2249168)	(0.4387853)

Source: Calculated

Note: t values of the estimated coefficients are given in the parentheses, ** and *** denote 1% and 5% significant level respectively

Table 4.15 The Result of Hausman Test

Test name	Test statistic	Significant level for rejection of the null hypothesis
Hausman test	0.00	1.0000

Source: Calculated

Null hypothesis: H_o: differences in coefficient not systematic

Note: accept null hypothesis indicates that MGE is inconsistent so that choose PMGE H_o is not rejected (there is not difference in the estimate coefficients), PMG is efficient

Table 4.16 The Result of Short run Cointegration of PMG

Independent Variables	PMG
lnEC, D1	0.1851869 (.1428262)
lnEC, LD	-0.0070688 (.0954563)
lnEX, D1	0.0383165 (0.0874132)**
lnEX, LD	-.0001197 0.039297
lnK, D1	0.0034167 (0.0656641)
lnK, LD	-0.0923278 (0.0525325)***
lnL, D1	-.1283479 (1.43003)
lnL, LD	1.184013 (0.7052894)***

Source: Calculated

Note: t values of the estimated coefficients are given in the parentheses, ** and *** denote 5% and 10% significant level respectively.

4.6 Result of FMOLS

Table 4.17 Result of Cambodia

	Variable	Coefficient	t-statistic
Cambodia	lnEC	0.06**	1.89
	lnEX	0.25***	6.37
	lnK	0.09**	1.85
	lnL	4.93***	8.12

Note: ** and *** significance at 5% and 1%, respectively

After testing FMOLS, for Cambodia the electricity consumption has the positive growth rate of GDP per capita; from table 4.17 lnEC is significance at 0.05 and the coefficient of lnEC is 0.06. Therefore, electricity consumption is very important to Cambodia. In addition, export also has the positive relation with GDP per capita in Cambodia; export has positive long run with GDP per capita. Therefore, export is very important in Cambodia and government needs to take more attention on export because export can improve the economic growth in Cambodia. In fact, since 1995 to 2011 Cambodia had the positive growth rate of export and government also improve the exported oriented policy in order to improve the economic growth in Cambodia. Capital has the positive relation with GDP per capita in Cambodia; the t-statistic of lnK is significance. Therefore, capital is a crucial input in order to improve the economic growth in Cambodia. Furthermore, labor has the positive relation with GDP per capita because of t-statistic of lnL is significance. The labor force of Cambodia also increases rapidly so that labor contributes the improving of economic growth in Cambodia. Ouédraogo (2009) analyzed the causality between electricity consumption and economic growth in Burkina Faso in 1968-2003. The empirical revealed that there are short and long run casuality test running from electricity consumption to GDP per capita in Burkina Faso. Odiahmbo (2010) examined the

relationship between electricity consumption and economic growth in Kenya from 1972-2006. The empirical results revealed that there is unidirectional causality between electricity consumption and economic growth in Kenya.

Table 4.18 Result of Thailand

	Variable	Coefficient	t-statistic
Thailand	lnEC	0.57**	4.79
	lnEX	0.06	0.76
	lnK	0.18***	5.75
	lnL	-1.05	-1.08

Note: ** and ***Significance at 5% and 1%, respectively

After testing FMOLS, for Thailand the electricity consumption has the positive growth rate of GDP per capital. The increasing of electricity consumption can improve the GDP per capita of Thailand. There is a significance of lnEC at 0.05 so that electricity plays very important in Thailand. The t-statistic of lnK is significance at 0.01. It reveals that capital has the long run relation with GDP per capita; capital inflow and FDI are very important for Thailand because it can improve the investment and economic growth in Thailand. Magazzino (2011) explored the energy consumption and aggregate income in Italy and this research focus from the period of 1970-2009, the empirical results revealed there is bidirectional causality between energy consumption and aggregate income. Binh (2011) examined the relationship of energy consumption and economic growth in Vietnam from 1976-2010. The empirical results show that there is a strong Ganger causality running from economic growth to energy consumption so that the energy conservation policy has little effect on growth. From table 4.19 shows that the error correction mechanism (ECM) is -0.11 so that there is the speed of adjustment revealed negative sign so it means that there are long and short run among those variables. In addition, ECM is -0.11 and significance so that if there are any short in the economy it adjusted that 11% that can move to the equilibrium. When growth is high and below the equilibrium level, it adjusts by approximately 11% within the first year in order to ensure the equilibrium

level. Nnaji et al (2013) the research revealed that ECM is -0.97 so it has long run relation when there has something shock in the economy. The speed of adjustment in this study is very high and the result indicated that the change in electricity consumption had significance impact on economic growth in Nigeria. All in all, if the error correction mechanism (ECM) reveals negative it means that there has the long run relation with those variables. There has the long run relation of electricity consumption and capital with GDP per capita in Thailand.

Table 4.19 Result of Vietnam

	Variable	Coefficient	t-statisitc
Vietnam	lnEC	0.53***	8.13
	lnEX	-0.09***	-2.91
	lnK	-0.06	-0.57
	lnL	-1.12	-0.52

Note: ** and *** Significance at 5% and 1%, respectively

After testing FMOLS, electricity consumption is significance so that there is a long run relation between electricity consumption and economic growth in Vietnam. Electricity consumption is significance at 0.01; electricity consumption has the long run relation with GDP in Vietnam. Export has the negative relation with GDP per capita and the t-statistic of lnEX is significance at 0.01; export and GDP per capita has the long run relation. Recently Vietnam meets the problems of inflation and inflation stood at 11.5% and 18.58% in 2010 and 2011 respectively. The inflation problem became the obstacle of Vietnamese export because when inflation increases, it increases the price of the goods and services. Therefore, export of goods and services cannot contribute to the GDP per capita in Vietnam. Binh (2011) examined the relationship of energy consumption and economic growth in Vietnam from 1976-2010. The empirical results show that there is a strong Ganger causality running from economic growth to energy consumption so that the energy conservation policy has little effect on growth. In addition, ECM is -0.18 and significance so that if there are any short in the economy it adjusted that 18% that can move to the equilibrium. When

growth is high and below the equilibrium level, it adjusts by approximately 18% within the first year in order to ensure the equilibrium level.

Table 4.20 Result of Malaysia

	Variable	Coefficient	t-statistic
Malaysia	lnEC	0.19***	6.56
	lnEX	0.4***	15.68
	lnK	0.15***	9.0
	lnL	-1.35***	-4.25

Note: ** and *** Significance at 5% and 1%, respectively

From table 4.20, for Malaysia electricity consumption has the long run relation with GDP per capita. lnEC is significance so that an increase of electricity consumption can improve the GDP per capita in Malaysia. Electricity consumption is significance at 0.01. Therefore, electricity consumption plays an important role in Malaysia. In addition, export is significance at 0.01; export also has the positive growth rate with GDP per capita; an increase of export can improve the GDP per capita. Government needs to take more attention on export oriented because it can improve the economy in Malaysia. Besides that, capital has the relation with GDP per capita in Malaysia. In fact, capital is very important for this country; in 1997 when it had the ASEAN financial crisis, there was a capital outflow from this country and GDP per capita also decreased as well. In 2008 the FDI accounted for 73.4% of total investment in Malaysia and the huge amount of FDI can brought more capital and improved the economic growth in Malaysia. Besides that, labor has the negative relation with GDP per capita in Malaysia; the t-statistic is significance at 0.001; there is the negative relation between labor and GDP. In addition, ECM is -0.10 and significance at 10% so that if there are any short in the economy it adjusted that 10% that can move to the equilibrium. When growth is high and below the equilibrium level, it adjusts by approximately 10% within the first year in order to ensure the equilibrium level.

Table 4.21 Result of Philippines

	Variable	Coefficient	t-statistic
Philippines	lnEC	0.64***	8.03
	lnEX	-0.07	-0.46
	lnK	0.46***	3.51
	lnL	-1.62***	-3.07

Note: ** and *** Significance at 5% and 1%, respectively

From Table 4.21 shows the cointegration among electricity consumption, export, capital, and labor. Electricity consumption has positive long run relation with GDP per capita because lnEC is significance at 0.01. In addition, capital also has the positive long run relation with GDP. An increase of capital can improve GDP per capita in Philippines. Capital is very important in this country because this country is the least developed country so that capital becomes the crucial factor to contribute to economy in Philippines. Furthermore, labor has the negative relation with economic growth of Philippines. Labor has the negative long run relation with GDP per capita in Philippines. Apergis et al (2012) tried to examine the relation of energy consumption and economic growth of Romania from 2000-2001; there is a long run cointegration of GDP and energy consumption. Kayhan et al (2010) explored the relationship between real GDP and electricity consumption from 2001-2010 and the empirical results showed that there is unidirectional causality running from electricity consumption to economic growth. In addition, ECM is -0.63 and significance at 63% so that if there are any short in the economy it adjusted that 63% that can move to the equilibrium. When growth is high and below the equilibrium level, it adjusts by approximately 63% within the first year in order to ensure the equilibrium level.

Table 4.22 Result of Singapore

	Variable	Coefficient	t-statistic
Singapore	lnEC	0.33**	2.40
	lnEX	0.38***	7.43
	lnK	0.14**	1.76
	lnL	1.09**	1.73

Note: ** and *** significance at 5% and 1%, respectively

Table 4.22 shows the relationship among electricity consumption, export, capital, labor, and GDP in Singapore by using FMOLS method. Electricity consumption has the long run relation with GDP per capita because the t-statistic is significance at 0.05. Furthermore, export has the relation with GDP per capita in Singapore. There is a positive relation between export and GDP per capita because the lnEX is significance at 0.01. Besides that, capital also has the long run relation with GDP per capita ant the t-statistic reveals significance at 0.05. Furthermore, labor has the long run relation with GDP per capita in Singapore because the t-statistic shows the significance. Due to the increasing of economic growth in Singapore, government needs more labor force to work in economic activities in the country. Due to the aging society in Singapore, labor force is also the problem in that country so that government needs to pay more attention on labor force.

Table 4.23 Result of Indonesia

	Variable	Coefficient	t-statistic
Indonesia	lnEC	0.30***	7.15
	lnEX	-0.02	-0.34
	lnK	0.39***	12.44
	lnL	0.73**	1.42

Note: ** and *** significance at 5% and 1%, respectively

From Table 4.23 shows the relation among electricity consumption, export, capital, labor, and GDP in Indonesia. There is relationship between electricity consumption and GDP per capita in Indonesia. The lnEC is significance at 0.01 so

there is the long run relation between electricity consumption and GDP in Indoneisa. Therefore, electricity consumption plays crucial in Indonesia economy. Furthermore, capital also has the long run relation with GDP per capita in Indonesia. The t-statistic of lnK reveals significance at 0.01. Besides that, labor has the long run relation with GDP per capita. Kayhan et al (2010) explored the relationship between real GDP and electricity consumption from 2001-2010 and the empirical results showed that there is unidirectional causality running from electricity consumption to economic growth. In addition, ECM is -0.07 and significance at 7% so that if there are any short in the economy it adjusted that 7% that can move to the equilibrium. When growth is high and below the equilibrium level, it adjusts by approximately 7% within the first year in order to ensure the equilibrium level.

Table 4.24 Result of Brunei

	Variable	Coefficient	t-statisitic
Brunei	lnEC	0.08**	2.54
	lnEX	0.25***	14.56
	lnK	0.05***	6.60
	lnL	0.27	1.10

Note: ** and *** significance at 5% and 1%, respectively

From Table 4.24 shows the relation among electricity consumption, export, capital, labor, and GDP in Brunei. There was long run relation between electricity consumption and GDP per capita in Brunei. There is the increase of demand of electricity consumption in Brunei and the increasing of electricity consumption can improve the economic growth in Brunei. The t-statistic reveals significance at 0.05 of lnEC. Furthermore, export has the long run relation with GDP per capita and significance at 0.01. Therefore, export plays the important role in contributing the economic growth in Brunei. Besides that, labor has the long run relation with GDP per capita. The t-statistic of lnK is significance at 0.01. Capital plays the important role in improving economic in Brunei.

Table 4.25 Result of Panel group of FMOLS

	Variable	Coefficient	t-statisitc
Panel Group FMOLS Result	lnEC	0.34**	14.67
	lnEX	0.15**	14.53
	lnK	0.18**	14.26
	lnL	0.24	1.22

Note: ** significance at 1%

Table 4.25 shows the relationship among electricity consumption, export, capital, labor, and GDP per capita of ASEAN countries by using panel group FMOLS method. There is long run relation between electricity consumption and GDP per capita of ASEAN countries. The t-statistic reveals significance at 0.01. Electricity consumption plays an important role in ASEAN region and electricity consumption contributes to improve the economic growth in ASEAN. Furthermore, export also has the long run relation with GDP per capita of ASEAN countries. The t-statistic is significance at 0.01. Besides that, capital has the long run relation with GDP per capita because the t-statistic is significance at 0.01. ASEAN's leaders need to have a good policy that can attract more capital inflow to that region in order to improving the economy in this region.

Table 4.26 Estimating Cointegration Vector

Method	PMG	FMOLS
lnEC	0.5***	0.34**
lnEX	0.45***	0.15**
lnK	0.30***	0.18**
lnL	0.17	0.24

Note: ** and ***Significance at 5% and 1% respectively

Table 4.26 shows the estimating cointegration by using PMG and FMOLS. PMG refers to Pool Mean Group estimator which proposed by Peasaran, Shin, and Smith (1999) and FMOLS refers to Fully Modified Ordinary Least Square (FMOLS) which proposed by Pedroni (2000). By using PMG estimator, the empirical reveals

that electricity consumption has the positive relation with GDP per capita of ASEAN; In contrast to FMOLS, lnEC is significance at 0.01. Furthermore, there is a long run relation of export by using PMG and FMOLS. The increase of export is very important to ASEAN countries because there is a positive coefficient of export to GDP per capita of ASEAN countries. Besides that, capital has the long run relation with GDP per capita of ASEAN countries. There is long run relation between capital and GDP per capita of ASEAN by using FMOLS. Capital is significance at 0.01; therefore, capital plays an important role in ASEAN. All in all, electricity consumption, export, capital have the long run relation with GDP per capita of ASEAN countries; only labor is insignificance so that labor does not have long run relation with GDP per capita of ASEAN countries.

CHAPTER 5

Conclusion and Recommendation

5.1 Conclusion of Research

This paper explored the determinant factors of economic growth of eight ASEAN members by using panel ARDL to estimate the data from 1995 to 2011. Using panel from 1995 to 2011 to estimate the determinant factors of eight ASEAN members; this paper illustrates the new evidence to use the advance panel econometric by using Pool Mean Group Estimator (PMG) and Mean Group Estimator (MG). By using PMG and MG to estimate the long run correlation between determinant factors of economic growth and economic growth of eight ASEAN members, this paper revealed that in the long run there does exist a co-integration relationship among electricity consumption, export, capital, and GDP. The elasticity of GDP per capita depend on electricity consumption per capita, labor, export per capita, gross capital per capita. In addition, after testing by using PMG and MG, it revealed the maximum of lag of this study is ARDL (2,2,2,2,2).

After using the method of Hausman test to select the criteria coefficient between Pool Mean Group Estimator (PMG) and Mean Group Estimator (MG), the result revealed that Pool Mean Group Estimator (PMG) is the better coefficient estimator to estimate the equation. The regression model of using the Pool Mean Group Estimator (PMG) showed there are positive relation among lnEC, lnEX, and lnK with lnGDP.

There are some advantages of doing this research; first, this research will be useful government to make a consideration on making on export and energy policy. Export is very important in ASEAN so government needs to take more export oriented in order to improve the economic in this region. Second, this research is useful for researchers and learners who need to know more about the relationship of electricity consumption, export, and economic growth in ASEAN.

In order to improve the economic growth in ASEAN region, ASEAN's leaders should have to consider investing on electricity sector more because it is the determinant factor to improve growth. In addition, improving exports is very important factor to improve the growth. Therefore, ASEAN's should continue improving exports not only intra ASEAN but also extra ASEAN and create more market friendly for investment to invest in this region.

5.2 Discussion of Research

By using ARDL approach to estimate the relationship of panel group, Pool Mean Group (PMG) reveals that electricity consumption, export, capital have the long run relation with GDP per capita of ASEAN countries. The coefficient of lnEC, lnEX, and lnK are 0.50, 0.45, and 0.30, respectively. There are positive sign of coefficient of lnEC, lnEX, and lnK; therefore, if there is an increase of electricity consumption, export, and capital, it can improve the GDP per capita of ASEAN countries. By using Hausman test, the empirical result reveals that PMG is the better estimator between PMG and MG estimator. The empirical results of PMG reveal that ASEAN government has to improve the investment in energy production, improve export, and attract more FDI to bring more capital inflow to region. Furthermore, the author used the Fully Modified Ordinary Least Square (FMOLS) method to test the cointegration of panel group. The empirical result of panel FMOLS shows that for Cambodia there are significance of lnEC and lnK significance at 0.05 and lnEX and lnL significance at 0.01; the increasing of electricity consumption, export, capital, and labor have the positive relation to GDP per capita of Cambodia. Cambodian government should improve in investment in energy production because it can improve the economic growth in Cambodia. Export has the positive relation with GDP per capita in Cambodia so that the increasing of export can improve the GDP per capita in Cambodia. lnEC and lnK are significance at 0.05 and 0.01 respectively; electricity consumption and capital have the long run relation with GDP per capita in Thailand;. Therefore, the improving of electricity consumption and capital is the important engine in improving Thailand economy. For Vietnam lnEC and lnEX have the long run relation with GDP per capita because there is significance at 0.01. The improving

of export cannot contribute much of GDP per capita because the world economic crisis and Europe debt crisis was also the obstacle of exporting of Vietnam's goods and services. lnEC, lnEX, lnK, and lnL are significance at 0.01 for Malaysia; the increasing of electricity consumption, export, and capital contribute to economic growth in Malaysia. Electricity consumption is the engine can contribute to economic growth in Malaysia and labor has the negative relation with GDP of Malaysia. For Philippines there are lnEC, lnK, and lnL are significance at 0.01 so that there are long run relation among electricity consumption, capital, and labor with GDP per capita of Philippines. There are positive relation of electricity consumption and export with GDP per capita in Philippines. Indeed, labor has the negative relation with GDP per capita in Philippines. The decrease of labor force can contribute to the economic growth in Philippines. For Singapore, electricity consumption, export, capital, and labor have the positive relation to GDP per capita in Singapore. The increase of electricity consumption, export, capital, and labor contribute to economic growth in Singapore. For Indonesia lnEC and lnK are significance at 0.01 and lnL are significance at 0.05 so that electricity consumption, capital, and labor have the long run relation with GDP per capita. The increasing of electricity consumption, capital, and labor can contribute to the economic growth in Indonesia. For Brunei lnEC, lnEX, and lnK are significance so that there are long run relation among electricity consumption, export, and capital with GDP per capita in Brunei. The increasing of electricity consumption, export, and capital can contribute to economic growth in Brunei.

5.3 Suggestions for Future Study

There are several possible extensions of this research. Firstly, due to the limitation of data, the author cannot include all the ASEAN members in this study. Indeed, the author does not include the all other determinant factors such as energy consumption, price, and investment. Secondly, this paper only detected on the determinant factors on the economic growth of eight ASEAN members and employed the long and short run relation between economic growth and determinant factors of economic growth. But this paper do not finding the casual relation between those

variables so the next research can work on this area. In addition, this research just looks in the big picture of ASEAN members so the next researchers can categorize the group of countries into agricultural based countries and transforming countries. Moreover, the next paper can do the causality among those variables by using Pool Mean Group (PMG) and Mean Group (MG) to estimate the relationship among those variables. Future study can focus on testing the relationship economic growth and the interaction term of electricity consumption and other factors of determinant factors of economic growth. Indeed, the study does not examine in detail of electricity consumption in different sources whether could lead to positive or negative effects on economic growth.

The increasing demand of electricity consumption will produce CO_2 to society so that government should have appropriate attention on the emission in order to develop this region in sustainable way.

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Appendix

Panel Unit Root Test

Table 1 Panel Unit Root Test of lnGDP

Methods	Levels		First difference	
	Statistic	Probabilities	Statistic	Probabilities
Null Hypothesis: unit root				
LLC	2.4413	0.9927	-14.1343	0.0000
Im-Peasaran-Shin	4.6693	1.0000	-9.2327	0.0000
ADF-Chi square	16.7758	0.4002	51.0132	0.0000
PP-Chi square	1.7362	1.0000	79.7629	0.0000

Table 2 Panel Unit Root Test of lnEC

Methods	Levels		First difference	
	Statistic	Probabilities	Statistic	Probabilities
Null Hypothesis: unit root				
LLC	-2.6820	0.0037	-6.6840	0.0000
Im-Peasaran-Shin	0.7409	0.7706	-6.1366	0.0000
ADF-Chi square	22.4422	0.1295	53.0987	0.0000
PP-Chi square	24.1480	0.0863	125.4261	0.0000

Table 3 Panel Unit Root Test of lnEX

Methods	Levels		First difference	
	Statistic	Probabilities	Statistic	Probabilities
Null Hypothesis: unit root				
LLC	-4.6584	0.0000	-10.2011	0.0000
Im-Peasaran-Shin	-0.3486	0.3637	-8.8421	0.0000
ADF-Chi square	37.1597	0.0020	43.9779	0.0002
PP-Chi square	11.9714	0.7459	172.5229	0.0000

Table 4 Panel Unit Root Test of lnK

Methods	Levels		First difference	
	Statistic	Probabilities	Statistic	Probabilities
Null Hypothesis: unit root				
LLC	-0.5027	0.3076	-6.1190	0.0000
Im-Peasaran-Shin	-0.1476	0.4413	-5.1414	0.0000
ADF-Chi square	40.1343	0.0007	64.0016	0.0000
PP-Chi square	11.6213	0.7696	106.1635	0.0000

Table 1.5 Panel Unit Root Test of lnL

Methods	Levels		First difference	
	Statistic	Probabilities	Statistic	Probabilities
Null Hypothesis: unit root (common unit root process)				
LLC	-3.6149	0.0002	-3.1184	0.0009
Im-Peasaran-Shin	2.5903	0.0048	-4.8963	0.0000
ADF-Chi square	57.1519	0.0000	55.8986	0.0000
PP-Chi square	9.8933	0.8721	73.3152	0.0000

Table 6 Pool Mean Group Regressions

Pooled Mean Group Regression

(Estimate results saved as pmg)

Panel Variable (i): id — Number of obs = 120

Time Variable (t): year — Number of groups = 8

Obs per group: min = 15

avg = 15.0

max = 1 5

Log Likelihood = 548.1342

D.lngdp	coef.	Std.Err.	z	P> lzl	[95%cof. Interval]
ec					
lnEC	0.5077437	0.0171388	29.63	0.000	.04741522
0.5413352					
lnEX	0.4552742	0.0484056	9.41	0.000	0.3604009
0.5501475					
lnK	0.3061301	0.0287978	10.63	0.000	0 .2496874
0.3625728					
lnL	0.1747972	0.1802113	0.97	0.332	-0.1784105
0.528005					
SR					
ec	-0.2249168	0 .1011799	-2.22	0.026	-0.4232258 -
0.0266079					
lngdp					
LD.	0.1272511	0.1969705	0.65	0.518	-0.258804
0.5133063					

Table 6 (continued)

D.lngdp	coef.	Std.Err.	z	P> lzl	[95%cof. Interval]
lnec					
D1.	0.1851869	0.1428262	1.30	0.195	-0.0947474
0 .4651212					
LD.	-.0070688	.0954563	-0.07	0.941	-
.1941596	.1800221				
lnex					
D1.	0.0874132	0.0383165	2.28	0.023	0 .0123142
0.1625122					
LD.	-.0001197	0.039297	-0.00	0.998	-0.0771403
0.0769009					
lnK					
D.	0.0034167	0.0656641	0.05	0.959	-0.1252825
0.1321159					
LD.	-00923278	0.0525325	-1.76	0.079	-
0.1952896	.0106339				
lnL					
D.	-.1283479	1.43003	-0.09	0.928	-2.931156
2.67446					
lnD.	1.184013	0.7052894	1.68	0.093	-0.1983285
2.566355					
_Constan	-0.2074883	0.1047426	-1.98	0.048	-0.41278 -
0.0021965					

Table 7 Mean Group Regressions

Mean Group Regression

(Estimate results saved as mg)

Panel Variable (i): id — Number of obs = 120

Time Variable (t): year — Number of groups = 8

Obs per group: min= 15

avg = 15.0

max = 1 5

Log Likelihood = 548.1342

D.lngdp	coef.	Std.Err.	z	P> lzl	[95%cof. Interval]
ec					
lnEC	-0.2543576	0.3393941	-0.75	0.454	-
0.9195579	.4108427				
lnEX	0.8356346	0.4342329	1.92	0.054	-0.0154463
1.686715					
lnK	-0.0723227	0.1839167	-0.39	0.694	-0.4327928
0.2881474					
lnL	-0.8775474	2.393035	-0.37	0.714	-5.567809
3.812714					
SR					
ec	0.4387853	2.459787	0.18	0.858	-4.382309
5.259879					
lngdp					
LD.	0.1595172	1.483722	0.11	0.914	-2.748525
3.067559					

Table 7 (continued)

D.lngdp	coef.	Std.Err.	z	P> lzl	[95%cof. Interval]
lnec					
D1.	0.8383757	0.9088633	0.92	0.356	-0.9429635
2.619715					
LD.	-0.1362366	0.1261814	-1.08	0.280	-.3835475
0.1110743					
lnex					
D1.	6522327	0.6518214	1.00	0.317	-.6253138
1.929779					
LD.	0.2482351	0.3608984	0.69	0.492	-0.4591129
0.955583					
lnK					
D1.	-0.361967	0.4363339	-0.83	0.407	-
1.217166	.4932317				
LD.	-.2586194	0.1399613	-1.85	0.065	-
0.5329386	.0156997				
lnL					
D1.	4.760917	5.472607	0.87	0.384	-5.965195
15.48703					
lnD.	-2.372877	4.126314	-0.58	0.565	-10.4603
5.714551					
_Constan	4.056541	4.559867	0.89	0.374	-4.880634
12.99372					

Table 8 Hausman Test

---- Coefficients ----

	(b) mg	(B) pmg	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
lnec	-.2543576	0.5077437	-0.7621013	1.37e+20
lnex	0.8356346	0.4552742	0.3803604	1.76e+20
lnk	-.0723227	0.3061301	-0.3784528	7.45e+19
lnl |	-.08775474	0 .1747972	-1.052345	9.69e+20

b = consistent under Ho and Ha; obtained from xtpmg

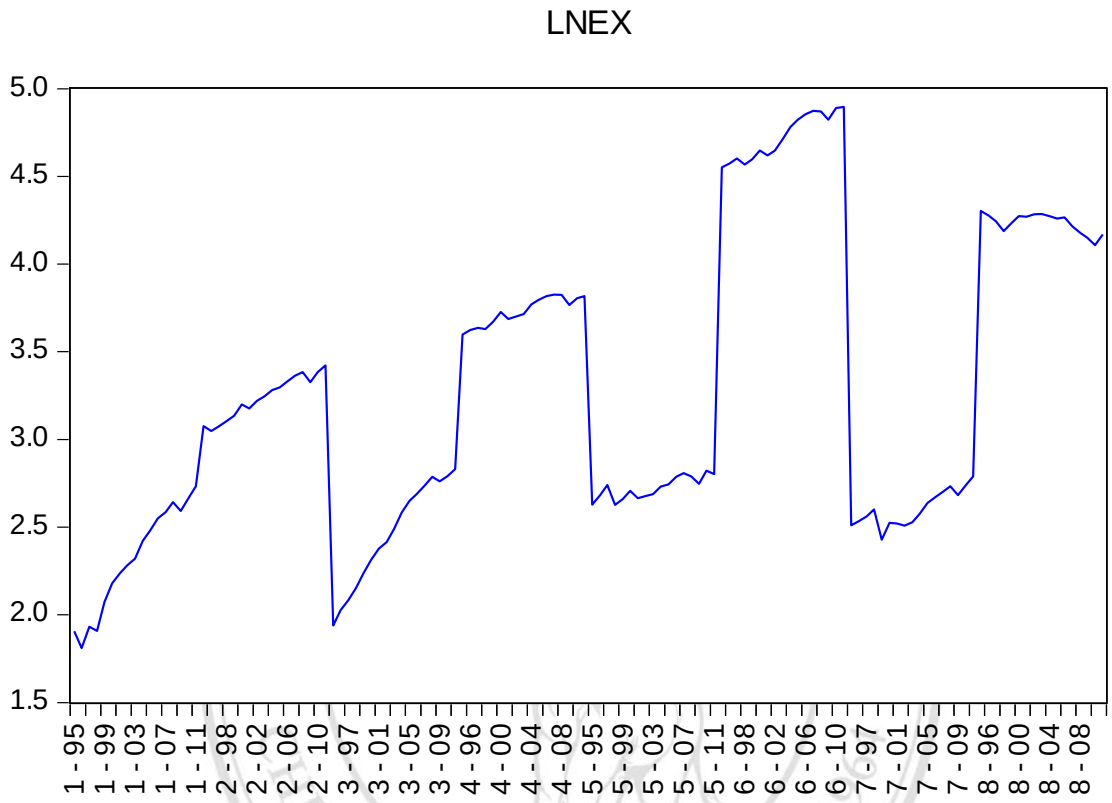
B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

Test: Ho: difference in coefficients not systematic

chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 0.00

Prob>chi2 = 1.0000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5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1 - 95
1 - 99
1 - 03
1 - 07
1 - 11
2 - 98
2 - 02
2 - 06
2 - 10
3 - 97
3 - 01
3 - 05
3 - 09
4 - 96
4 - 00
4 - 04
4 - 08
5 - 95
5 - 99
5 - 03
5 - 07
5 - 11
6 - 98
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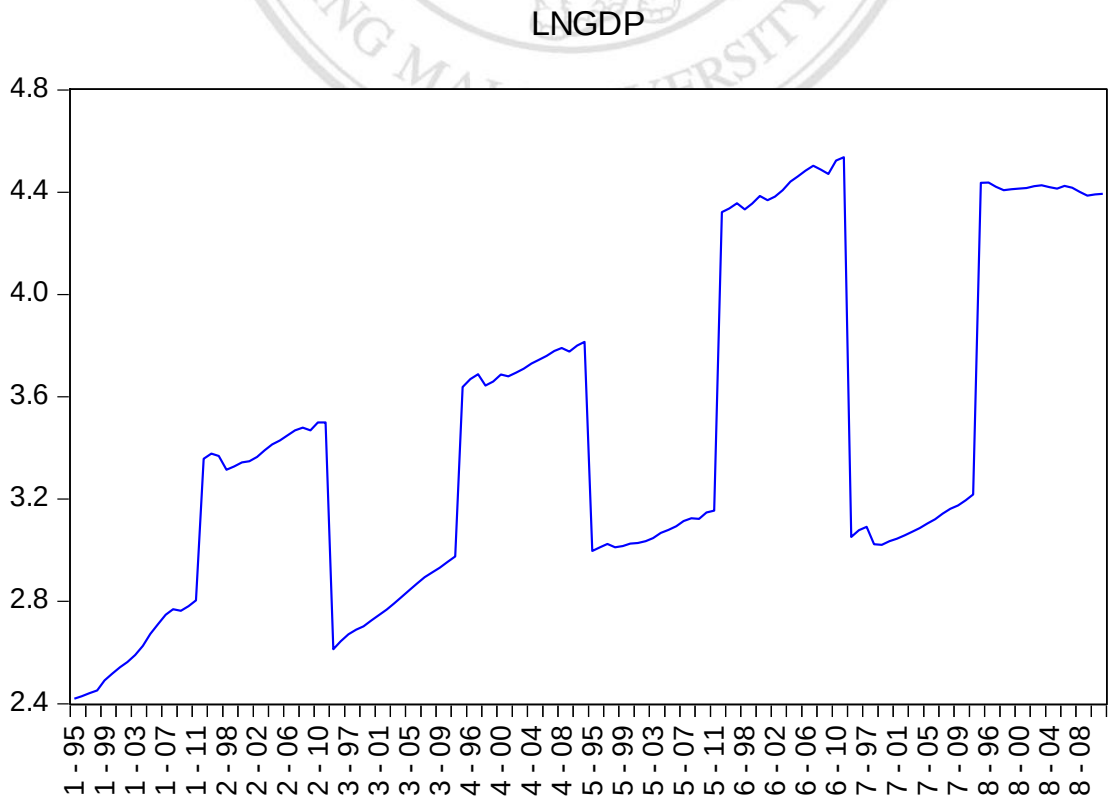
6 - 06
6 - 10
7 - 97
7 - 01
7 - 05
7 - 09
8 - 96
8 - 00
8 - 04
8 - 08


LNGDP
4.8
4.4
4.0
3.6
3.2
2.8
2.4
1 - 95
1 - 99
1 - 03
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2 - 02
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3 - 05
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4 - 00
4 - 04
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5 - 99
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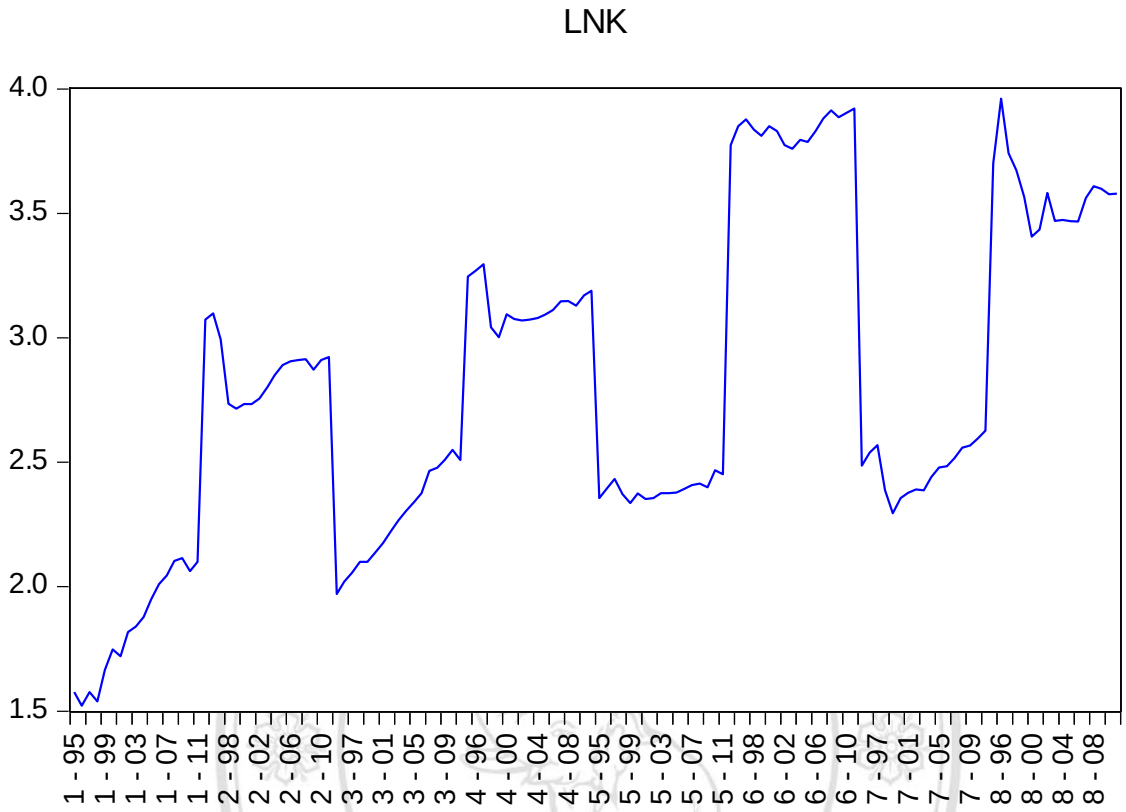
LNK
4.0
3.5
3.0
2.5
2.0
1.5
1 - 95
1 - 99
1 - 03
1 - 07
1 - 11
2 - 98
2 - 02
2 - 06
2 - 10
3 - 97
3 - 01
3 - 05
3 - 09
4 - 96
4 - 00
4 - 04
4 - 08
5 - 95
5 - 99
5 - 03
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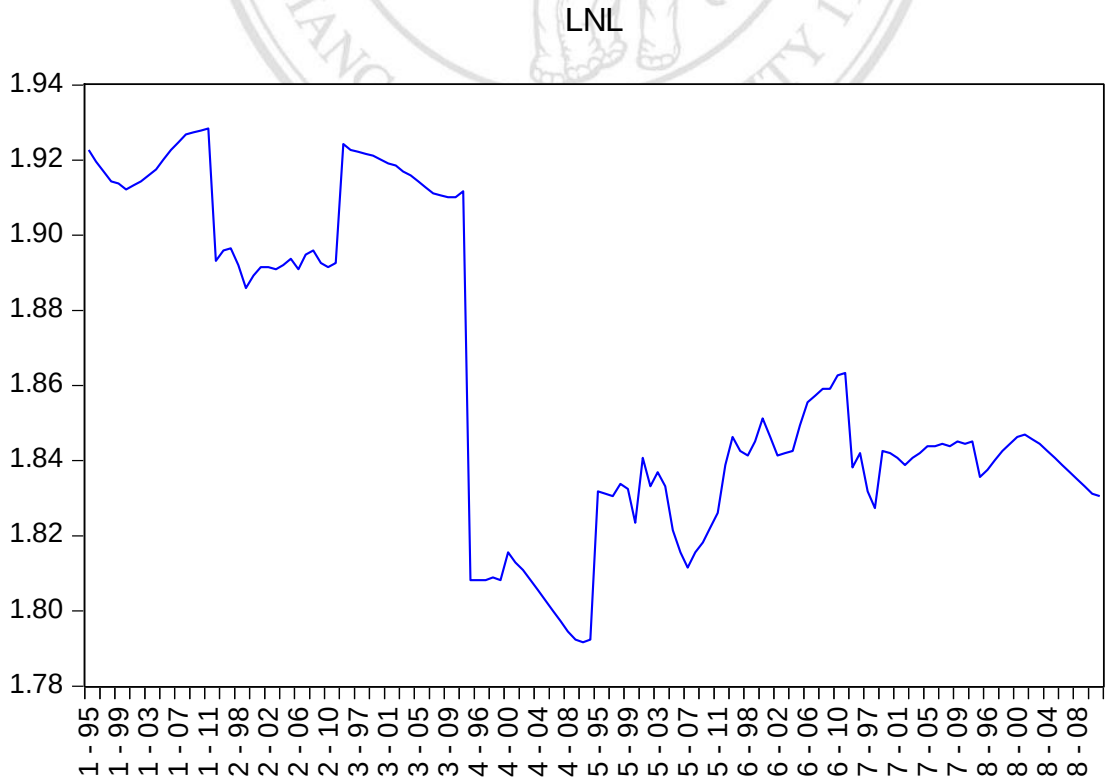
8 - 08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1.90
1.88
1.86
1.84
1.82
1.80
1.78
1 - 95
1 - 99
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1 - 07
1 - 11
2 - 98
2 - 02
2 - 06
2 - 10
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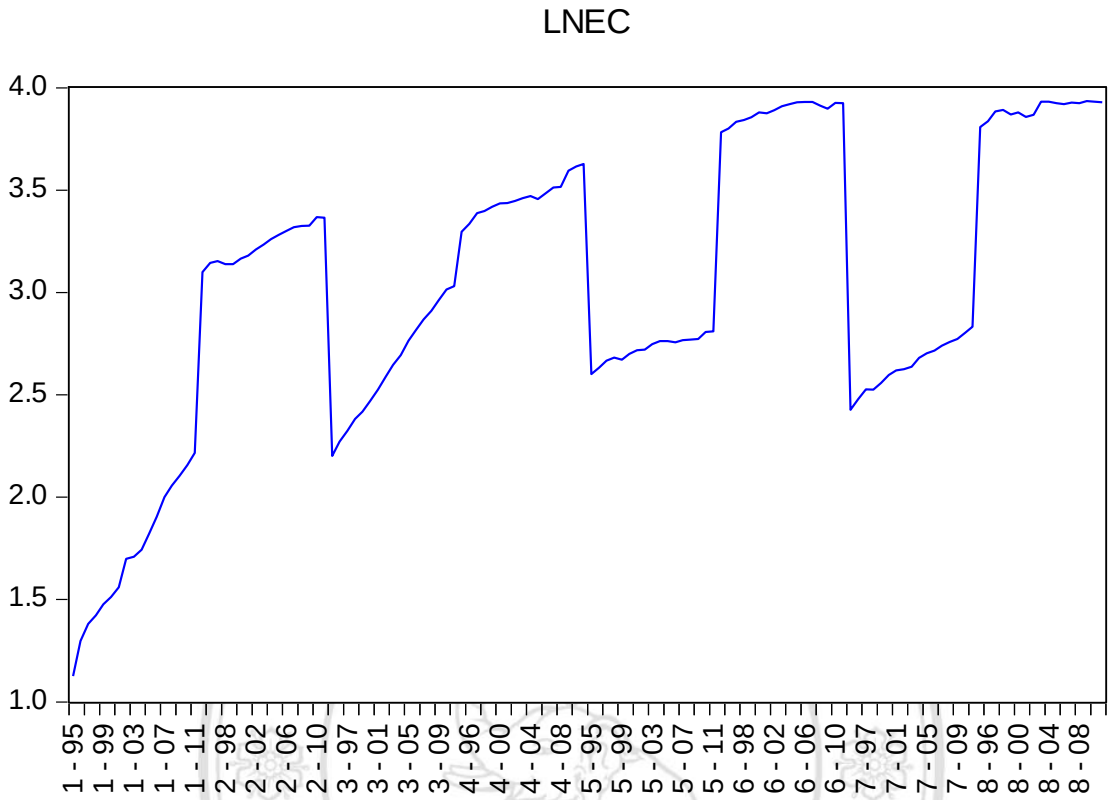

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